AD-A169 182 PROCEEDINGS OF THE ANNUAL MEETING OF THE TECHNICAL DOCUMENTATION DIVISION..(U) AMERICAN DEFENSE PREPAREDNESS ASSOCIATION ARLINGTON VA MAY 79 1/3

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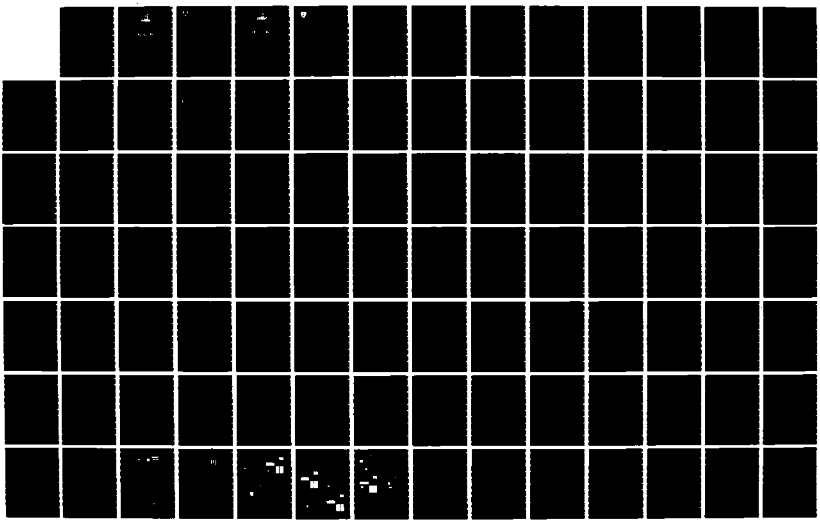

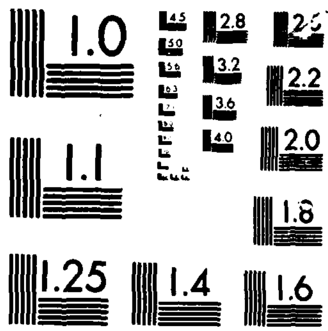
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PROCEEDINGS

TWENTY-FIRST ANNUAL MEETING

TECHNICAL DOCUMENTATION DIVISION

23-25 MAY 1979

Naval Postgraduate School
Monterey, California

AMERICAN DEFENSE PREPAREDNESS ASSOCIATION

NATIONAL HEADQUARTERS: Union Trust Building, Washington, D. C. 20005

AMERICAN DEFENSE PREPAREDNESS ASSOCIATION

DEDICATED TO PEACE WITH SECURITY THROUGH DEFENSE PREPAREDNESS

UNION TRUST BUILDING 15TH AND H STREETS, N. W., WASHINGTON, D. C. 20005
202-347-7250

Founded 1919

Dear Fellow ADPA Member:

Your response to this questionnaire is requested to help us identify problems with Technical Documentation in the defense industry. The Technical Documentation Division is proud of the close and effective relationship between its industry and government members. It is through this relationship that we can identify and resolve problems for the simplification and improvement of Technical Documentation. Your participation is essential.

Please take a few minutes, complete the following questionnaire, and mail it to:

T. L. Golmis
Hughes Aircraft Company
Bldg. 604, M/S F-122
P. O. Box 3310
Fullerton, CA 92634

---

1. What feature or talk given at the 1979 meeting was the most informative? ______________________

   . . . Helpful to you? ______________________

2. What problems are you having that you would like to see resolved?

   ____

   ____

3. What subjects would you like to hear discussed at the 1980 meeting, to be held in CHARLESTON, SOUTH CAROLINA? ______________________

   ____

Your answers will be reviewed by the TDD Executive Board. Where necessary, ad hoc committees of industry and government members will be created to work your problems.

Sincerely,

T. L. Golmis
Chairman,
Technical Documentation Division

TLG/eve

P.S.: Comments and suggestions are invited on the reverse or attach additional sheets.

PROCEEDINGS

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THE MISSION

OF

THE AMERICAN DEFENSE PREPAREDNESS ASSOCIATION

The American Defense Preparedness Association exists solely for the advancement of adequate national defense of the United States in the fields of weapons technology, production, and logistics. We strive to improve the effectiveness and efficiency of the Government-Science-Industry relationship in the development and production of weapons and weapons systems. Our field of interest covers all ordnance, armament, weapons, weapons systems, and related equipment for the Armed Forces of the United States. Our interest also includes techniques, processes, and materials that have wide application in the development, production, and logistics of weapons.

Through its publications and meetings--national, local, and technical--the Association endeavors to educate its members and the public on problems affecting weapons preparedness. Our technical divisions provide advice to Government agencies on weapons technology.

The Association, founded in 1919, is a non-profit and non-political organization. It is an association of individuals as distinguished from an organization of commercial companies. The ten persons nominated by company members participate as individuals.

It is not within the scope of any American Defense Preparedness Association meeting or activity to discuss or be at all concerned with matters of trade, procurement, price, market or control or with placement of specific contracts or allocation of materials.

The Association cooperates to every practical extent with other recognized technical and industrial associations in assisting the Armed Services of the United States. Its mission is to keep America's armament strong in peace and in war. Its functions are as important and as worthy of support in times of international quiet, as well as in emergency. It is a peace society in purpose, in operations, and in fact.

AMERICAN DEFENSE PREPAREDNESS ASSOCIATION

TECHNICAL DOCUMENTATION DIVISION

STATEMENT OF AIMS AND PURPOSES

The Technical Documentation Division is part of the Defense Management Group of the American Defense Preparedness Association. The division was formed to provide the government and industry access to a group of experienced and responsible administrators and specialists from various sectors of industry, qualified to assist in the formulation of government and industry requirements for technical documentation. The members participate as individuals rather than representatives of their companies.

The division is concerned with all aspects of technical documentation: conception, analysis, preparation, management, control, and dissemination. The division's field of interest includes engineering drawings and standards, policies and procedures, technical publications, specifications, configuration controls, computer aided documentation techniques, and methods of data communication. Duplication of effort by other technical and industry associations is avoided.

Sections/Committees are established to study problems and submit resulting reports and recommendations. Section/Committee participation by an individual is voluntary and evidences his desire to comprehend government and industry needs, to reduce the complexity and cost of technical documentation, and to enhance standardization with a sincere interest to serve with other members to achieve these goals.

Division/Section members interface frequently with their counterparts in government and industry. This association serves as a clearinghouse for professional information interchange and provides a stimulation which contributes toward the success of the participant's work and enhances the individuals value to his employer.

In addition to section/committee reports on subjects completed or in process, the Technical Documentation Division convenes annually and conducts a program of timely subjects to keep the members and the public informed, alert, and interested in the problems and solutions associated with technical documentation vital to our national defense, industrial accomplishments, and other related programs.

CONTENTS

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TECHNICAL DOCUMENTATION DIVISION

SECTIONS AND COMMITTEES

Armed Services Procurment Regulations Section	C.D. Fisher
Awards Committee	J.R. Meitz
Computer Software Section	Orman Baker
Configuration Management Section	C.J. Embrey
Contract Data Management Section	J.R. Hart
Engineering Data Automation Section	Dr. P.C.C. Wang
Engineering Drawing Requirements Section	J.R. Meitz
International Data Requirements Section	T.L. Golmis
Metrication Section	Lorna Burns
Micro-Reproduction Systems Section	J.R. Sutton
Preparation and Management of Specifications Section	S. Alvine, Jr
Technical Publications Section	R.E. Knob

Award Presentation May 23rd, 1979

THE

R.H. STEARNS

AWARD

Presented to

Maurice E. Taylor

In every field of human activity there are those who lead and those who are led. Occasionally, among the leaders there are individuals who achieve superior stature. In the field of Engineering Documentation, Robert H. Stearns was one who, through dedication to principle and aggressive pursuance of duty, earned outstanding recognition in both industry and military circles.

Born in 1906 in New York City, Mr. Stearns' career included training both as a machinist and in engineering at White Motor Co., and as a drawing checker, chief checker, chief draftsman and engineering consultant during twenty-five years of service with the Douglas Aircraft Company.

He was also active personally and as the Douglas representative on various industry association activities, special advisory committees to the Department of Defense, and with the Engineering Data Management Section of the American Ordnance Association. He was taken from us by a most unfortunate aircraft accident en route home from a meeting of the Steering Committee of the Engineering Data Management Section in February 1962.

In recognition of his outstanding achievements, the *Robert H. Stearns Award* was established for the purpose of honoring Mr. Stearns and as a vehicle to recognize and honor those who might exhibit comparable qualities and achievement in the future. Specifically, candidates for the Award are judged on the basis of demonstration of outstanding qualities in the following attributes:

- Devotion to the field of documentation and meaningful achievement therein
- Vigorous and articulate in establishing and logically supporting a position
- Energetic with singleness of purpose
- Patriotic, honorable, pleasant, humble, sincere.

PAST RECIPIENTS OF THE AWARD	
The Family of R.H. Stearns	1963
W. W. Thomas	1964
P. C. Weissbrod	1966
J. H. Mars	1968
D. S. Scott	1969
P. G. Belitsos	1969
C. A. Nazian	1970
J. L. Flippo	1970
R. F. Franciose	1971
G. D. Christensen	1972
C. A. Fricke	1973
J. R. Meitz	1974
D. R. Mitchell	1977
H. R. Lowers	1978

Mr. Maurice E. Taylor has been actively engaged in the field of engineering documentation for over 30 years. He is a graduate of Lehigh University and has 35 years of government service. Our history record shows Mr. Taylor as a specification writer for Fire Control in the late 1940's and early 1950's. In the early 1950's, when the Department of Defense initiated the standardization program, Mr. Taylor became Chief of the Specifications/Standards Section at the Frankford Arsenal.

Mr. Taylor is presently Chief ARRADCOM-Specifications and Standards Section located at Picatinny Arsenal, Dover, New Jersey. He is also the Manager of the DOD DRPR Program; Chairman of the DOD Select Committee on DOD-D-1000, which includes DOD-STD-100; principal member of the U.S. Army Quadripartite Working Group on Engineering Standardization Program; ABCA-UES Army Liaison; ARRADCOM member of the Engineering Design Advisory Group; a member of a number of ANSI committees; and, last but not least, the Army Liaison member of our ADPA Technical Documentation Executive Board.

Because of his knowledge and background, Mr. Taylor is a focal point for both industry and military personnel's questions and requests for consultation. His combined leadership and fundamental good background have brought him increasing respect as he, in his quiet and effective manner, works through one task after another in the development of the various aspects of standardization.

Through his leadership, continued revisions to the drawing standards are bringing industry and military closer to a single national standard. Mr. Taylor is truly dedicated to the promotion and use of specifications and standards. He has always been responsive to the needs of industry as well as the Department of Defense. One of his present concerns is the impact of international standardization on national industry/military standards.

Mr. Taylor has been associated with the ADPA Technical Documentation Group for many years, and his contributions are innumerable. He is a frequent speaker at our annual meetings and regularly attends our Steering Committee meetings, keeping us informed of the latest developments.

We value his support of our endeavors and look forward to the guidance and professionalism he adds to our group.

He and his wife Lois live in Riverton, New Jersey, and were blessed with four children. He has two married daughters and a son and a daughter in college. He is a grandfather of two boys and two girls.

Mr. Taylor is an ardent fishing and boating enthusiast and enjoys traveling.

A person who possesses the unique qualities and high standards to merit this award – dedication to the field of standardization, articulation, responsiveness, humility, sincerity – is Maurice E. Taylor.

American Defense Preparedness Association

TECHNICAL DOCUMENTATION DIVISION

TWENTY-FIRST ANNUAL MEETING

Program Chairman:

ROBERT H. CARRIER
Raytheon Company

Business Manager:

DR. PETER C.C. WANG
Naval Postgraduate School

SESSION 1

Chairman: JOSEPH V. SYMANOSKIE
E-Systems Incorporated
Melpar Division

Secretary: BURTON G. SHAEFER
Pitney Bowes
Copier Products Division

WELCOMING ADDRESS

REAR ADMIRAL TYLER F. DEDMAN
Superintendent
Naval Postgraduate School

Admiral Dedman graciously welcomed the Technical Documentation Division of the American Defense Preparedness Association to the Naval Postgraduate School. He discribed the current role of the school in our national defense and provided a brief summary of history of the Naval Postgraduate School. He expressed his appreciation to the division for opening the meeting to students of the school.

American Defense Preparedness Association

TECHNICAL DOCUMENTATION DIVISION

1979 ANNUAL REPORT

by

THEODORE L. GOLMIS
Manager, Configuration and Data Management Operations
Hughes Aircraft Company

and

Chairman, Technical Documentation Division

Good morning, ladies and gentlemen. I would like to take this opportunity to express my personal appreciation and that of the American Defense Preparedness Association to all of the individuals that have made this meeting possible.

In particular, I would like to thank Rear Admiral Dedman for his kindness in hosting our twenty-first annual meeting of the Technical Documentation Division here at the Naval Postgraduate School. We are indeed privileged to be able to share the facilities of one of the finest graduate institutions in the Country in a setting as lovely as the Monterey Peninsula.

It also gives me great pleasure to thank Mr. Robert H. Carrier, Raytheon Company, our Program Chairman and Dr. Peter C. C. Wang, Naval Postgraduate School, our Business Manager who have worked for months formulating, arranging, and managing this twenty-first annual meeting. Thank you gentlemen.

It has been our custom each year to open our meeting with an annual report. Last year in New Orleans, because that meeting represented our Twentieth Anniversary, I attempted to recap our first year and highlight the other nineteen years. At that meeting, I stated that two decades ago under the banner of Engineering Documentation Section of the American Ordnance Association, this group became actively involved in matters associated with Defense and Space Documentation. A small dedicated group interested in problem solving, initiated a movement that has lasted twenty years. I said, "twenty years ago men with insight set as their objectives for this section the establishment of a two-way channel of communication between military and industry. They hoped to provide a sounding board by which the military could obtain the benefits of a cross-section of industry experience through the coordination of information regarding new requirements and problems."

Since twenty years is too much to cover in the alloted time, I would like to highlight, in slightly more detail, our last five years--looking at objectives and accomplishments.

Five years ago at Stouffer's Riverfront Inn in St. Louis, Missouri, Mr. Joseph R. Meitz, Delco Electronics, our Section Chairman at that time, set forth the objectives for the year to come. They included:

(1) Increase our Steering Committee from the existing seventeen members to twenty.

(2) Broaden our interest base and establish appropriate committees for such activities.

(3) Continue our push with ADPA Headquarters to establish a working relationship with the American National Standards Institute (ANSI).

(4) Establish closer working relationships with other groups and industry associations.

(5) Continue our efforts for closer and better working relationships with the Department of Defense (DoD) and the individual branch Services.

Those objectives basically set the goals for that coming year and the years that followed. Here is how they have been satisfied:

(1) Increase the Steering Committee from the existing seventeen to twenty.

This was accomplished in that first year and we have retained a membership of twenty or more since that time. The current Steering Committee, now known as the Executive Board, consists of:

Officers:

Chairman	Theodore L. Golmis, Hughes Aircraft Co
Secretary	Robert A. Timlin, Martin Marietta Corp
Membership	Joseph V. Symanoskie, Melpar Division, E-Systems, Inc

Members:

Samuel Alvine, Jr	Kearfott Division, Singer Company
Joseph F. Armijo	Tracor Incorporated
Orman Baker	Texas Instruments
Richard R. Barta	IBM Corporation
Lorna Burns	Hughes Aircraft Company
Robert H. Carrier	Raytheon Company
Donald C. Derosia	General Electric Company
Charles D. Fisher	RCA Corporation

Members (continued)

Robert F. Franciose	General Electric Company
Charles W. Gedney	Research Analysis and Management Corp
John R. Hart	Boeing Aerospace Company
Richard E. Knob	Sperry Rand Corporation
Ralph Lysyk	Addressograph Multigraph Corporation
Joseph R. Meitz	General Motors, Delco Electronics
Joseph O'Callahan	Avondale Shipyards Incorporated
Burton G. Schaefer	Pitney Bowes
John R. Sutton	General Electric, Ordnance Systems
Dr. Peter C.C. Wang	Naval Postgraduate School

Government Liason Representatives:

Richard L. Berry	Naval Material Command
John J. Durante	U.S. Marine Corp
James D. Federline	Defense Logistics Agency
Lt Col William Fohrman	U.S. Air Force, WPAFE
Maurice E. Taylor	U.S. Army, ARADCOM

The Steering Committee was restructured as an Executive Board at the Division level in 1977 and now includes the various Section Chairmen (formerly Committee Chairmen).

January 1978 marked the first of the newly formatted Executive Board Meetings. The meeting was held "on-post" at Redstone Arsenal, Huntsville, Alabama. Our host was the ADPA Tennessee Valley Chapter. Colonel Michael Dooley, Army Missile Materiel Readiness Command and President of the Tennessee Valley Chapter; Mr. Horace Lowers; and Mr. Leland Womack assisted in those arrangements. The meeting was attended primarily by civilian elements of Redstone Arsenal. The Military Liason Representatives and Section Chairmen reports were well received and provided an excellant exchange with attendees.

Our second such meeting was held at Eglin Air Force Base, Fort Walton Beach, Florida. The meeting was arranged through Colonel Clifford Allen, Chief of Guided Weapons and President of the ADPA Gulf Coast Chapter. This meeting aided in determining the current interests and suggested topics that we should address at this annual meeting.

Our objective is to enhance our annual meetings by taking advantage of those "participant with a message" that we encounter through these Executive Board meetings. We will accumulate new topics, timely subject matter, and unresolved problems--hopefully--for resolution at our Annual Meetings. Both the Annual Meeting

and Executive Board Meetings will be rotated around the United States to maximize our exposure to the "real world" and expand the exchange of current information between government and industry.

(2) <u>Broaden our interest base and establish appropriate committees (sections) for such activities.</u>

The existing committees, sections, and their chairmen are as follows:

<u>Sections</u>

Armed Services Procurment Regulations	C.D. Fisher
Computer Software	Orman Baker
Configuration Management	C.J. Embrey
Contract Data Management	J.R. Hart
Engineering Data Automation	Dr. P. Wang
Engineering Drawing Requirements	J.R. Meitz
International Data Requirements	T.L. Golmis
Metrication	Lorna Burns
Micro-Reproduction Systems	J.R. Sutton
Preparation and Management of Specifications	S. Alvine, Jr
Technical Publications	R.E. Knob

<u>Committees</u>

Awards Committee	J.R. Meitz

The establishment of these sections seems now to adequately cover the field of technical documentation and permits our involvement in many interrelated activities and interest areas.

Let me highlight some of our sections' activities and interests:

<u>ASPR Section - Charles D. Fisher</u>

This section is standing by for action. The past years have contributed to some very interesting activity, but now under the new "Acquisition Regulation Committee" and with the transition from ASPRs to Federal Acquisition Regulations (FARs) we should see significant changes in the areas of deferred ordering, government wide procurement of automated data processing (ADP) capabilities and rights in software data, data required by ASPR not listed in the Contract Data Requirements List (CDRL), data pricing, engineering change proposals (ECPs), and contract clauses. 1979-1980 should be a most interesting year.

Computer Software Section - Orman Baker

The scope of this section is limited to the documentation in an engineering drawing system of computer programs that are delivered to a customer. It is not the intent to cover all aspects of computer programs, per se. A description of Computer Software Drawings has been submitted for inclusion in ANSI Y14.24, "Types and Application of Engineering Drawings" (proposed). This document is expected to replace Chapter 200 of DOD-STD-100C (formerly MIL-STD-100).

Comments have been received on the Navy coordinated specification for Software Management, MIL-STD-1679, and are currently being consolidated for submittal to the Navy. A list of definitions dealing with computer program terminology is currently being compiled.

Configuration Management Section - Charles J. Embrey

Mr. Embrey has just recently taken over this section. We were terribly saddened shortly after last year's annual meeting when our Program Chairman for that year and CM Section Chairman, Lyle Alexander, passed away.

There is significant activity on the horizon for this section and we expect to see a number of improvements in the documents originating from the Joint DoD Configuration Management Committee under the chairmanship of Richard L. Berry, Naval Material Command.

Activity in the recent past includes involvement in the industry review of the DoD CM Standardization Plan; DoD Directive 4120.3, Defense Standardization and Specification Program; MIL-STD-480A, Configuration Control, Engineering Changes, Deviations, and Waivers; and participation in the Arlie House workshop on MIL-STD-480 Tailoring Guide, MIL-HDBK-248, Tailoring Guide for Application of Specifications and Standards, MIL-HDBK-245, Preparation of Statement of Work, MIL-STD-35, Automated Engineering Document Preparation, MIL-STD-XXX, and Configuration Management Practices.

Contract Data Management Section - John R. Hart

This section has commented on a preliminary draft of DOD Directive 5100.36, "Development and Acquisition Information". (This directive is the parent document for DoD Directive 5010.12, "Management of Technical Data".) DoD Directive 5000.32M (draft), "Acquisition Management Systems and Data Requirements Control Program Manual" was sent to fifty-two section and division members for

review and comment. Serveral items resulting from last year's workshop on data have developed into assignments. They include:

Development of consensus DIDs - Chairman M. Michaelis, U.S. Navy

Reduction in use of DD Form 250 for the delivery of data - R. Hall, Motorola.

Upstream mutual RFP involvement - J. Parish, U.S. Air Force.

During the next quarter, the Contract Data Management Section plans to:

-Follow-up on DoD Directive 5000.32M draft.
-Complete 1979 workshop action items.
-Continue on-going review of government media.

Engineering Data Automation Section - Dr. Peter C.C. Wang

In November 1979, this section will sponsor the Second Symposium on Automated Technology in Engineering Drawings here at the Naval Postgraduate School. There will be special sessions on automated production of digitized engineering data, storage, retrieval, display and transmission of digital data, and the future of automation technology in engineering data. (I understand that we have approximately three hundred who have indicated a desire to attend.)

Engineering Drawing Requirements Section - Joseph R. Meitz

This section now consists of forty active members. The section's prime effort this past year was confined to a final review of the Guide for Application and Tailoring of DOD-D-1000 which is now Amendment 1 to that document.

Tasks planned for 1979 include:

-Envolvement with numbering, nomenclature, and drawing package callout of software.

-Review of the proposed revision to the Air Force document AFAD-71-700.

-Review of ANSI documents planned to replace military specification and standards related to drawings, as proposed.t

-The priority task for this section will be to review and propose clarifications of the

definition and requirements for procurement documentation including specification and source control drawings. This task is the result of a request from the Defense Material Specification and Standards Office (DMSSO).

International Data Requirements Section - T.L. Golmis

International data requirements are getting a great deal of attention as the result of the recent DoD/NATO agreements in the areas of Reciprocal Defense Procurement, Principles Governing Mutual Cooperation in Research, Development, Production, and Procurement of Defense Equipment, and NATO Rationalization, Standardization, and Interoperability (RSI) Working Group. Section activity should be increasing in the coming year.

Metrication Section - Lorna Burns

The Metrication Section consists of twenty-five industry members and eight government liason representatives. This section is responsible for reviewing government directives, standards, and specifications involving metrics; respoinding to ANSI's requests for public review of proposed national metric standards; providing metrication guidance and assistance to various branches of the government upon request; and keeping members informed of current trends and activities relative to metrication. These activities have included review of:

DOD-STD-1476	Metric System, Application in New Design
DOD-M-24680	Metric Machinery/Equipment, General Requirements for
ANSI B4.2-1978	Preferred Metric Limits and Fits
ANSI B4.3-1978	General Tolerances for Metric Dimensioned Products

A proposed revision of the national standard for metric practices, IEEE STD 268-1979, has just been sent to section members for review.

Micro-Reproduction Section - John R. Sutton

The latest development in this section is an invitation to assist in the review of a DoD specification promoted by the National Micrographics Association and Wright Patterson Air Force Base.

Preparation and Management of Specification Section - Samuel Alvine, Jr

Mr. Alvine's big task this year was the coordination of the combined standard DOD-STD-490/961. I won't expand upon this review, since you will be discussing the subject later.

Technical Publications Section - Richard E. Knob

In addition to arranging for ADPA sponsorship of the Integrated Technical Documentation and Training (ITDT) Workshops for industry, this section is interested in reducing the number of specifications required for technical manuals.

I think this brief summary of activities pretty well indicates our broadened interest base.

(3) Continue our push with ADPA to establish a working relationship with ANSI.

We have been very fortunate over the years to have on our Executive Board Bob Franciose, Chairman of the Y14 Executive Committee which is responsible for a majority of the ANSI documents which we use. Through him, and people like Charles A. Fricke, Chairman of the Y32 Committee, and Lorna Burns and Joseph R. Meitz, both Chairmen of Y14 Subcommittees, we have been able to remain informed and to participate in the development and revision of ANSI standards.

(4) Continue to establish closer working relationships with other groups and industry associations.

We have over the last several years developed an excellent working relationship with AIA, EIA, and NSIA. They joined us on the five city, nationwide Seminar on MIL-D-1000/MIL-STD-100, on the East Coast/West Coast Seminar on Tailoring of Specifications and Standards, and the Arlie House Workshop. This cooperative effort has afforded us many opportunities to eliminate duplication of effort and maximize our industry positions through unification.

(5) Continue our effort for closer and better working relationship with the DoD and individual branch Services.

The fullfilment of this objective has been very rewarding. Five years have seen significant improvement in our relationship with DoD and the Services and have resulted in benefits to both Government and industry. DoD's support of the MIL-D-1000/MIL-STD-100 Seminars,

and the Tailoring Seminars and Workshop, made them worthwhile ventures. A good working rapport made possible the inclusion of the substitution statement in MIL-STD-480, defeated the 32-digit number proposal, and permitted the establishment of an investigative task team under DARCOM for the review of duplicate drawing problems.

The closer and better working relationship with DoD and the individual branches Services must always be our Number One objective.

Those were the objectives in 1974 as established by Mr. Meitz. In addition to fulfilling those objectives, we have seen many other accomplishments including a continual improvement in our annual meeting. Our speakers have been outstanding, our workshops ever growing, and attendance increasing. (By the way we have tentatively selected Charleston, South Carolina as the site of our next annual meeting.)

I am extremely proud of the men and women who have contributed so much to the success of this organization and thank you who attend our meetings and exchange with us your knowledge and expertise so that we may better serve government and industry.

Thank you.

SOFTWARE CONFIGURATION MANAGEMENT

John A. Campbell
Software Staff Engineer

Martin Marietta Aerospace
Denver, Colorado

A presentation of a practical approach to software configuration management based upon actual methods and procedures that were successful in achieving configuration management of flight operations software on the Viking project.

SOFTWARE CONFIGURATION MANAGEMENT

I. INTRODUCTION

Applying the configuration management disciplines to hardware end products has been successfully accomplished for many years. However, when these same disciplines are applied to the software end product, there appears to be difficulty in understanding when and how to apply them.

An in-depth discussion of all of the potential procedures that could be implemented to achieve software configuration management is not possible in the time allotted for this presentation. Therefore, this presentation will highlight the procedures that were successful on the Viking project for software configuration management.

II. VIKING SOFTWARE CONFIGURATION MANAGEMENT

The major factor in achieving successful software configuration management on the Viking project was the implementation and strict enforcement of disciplines on the software development personnel.

Detailed schedules were established for all phases of software development as well as for the preparation of specifications, test plans, and support documentation. Schedule status was reviewed at regular weekly reviews and all software problems were highlighted and resolved on a scheduled basis.

The total responsibility for the development of the Viking Lander software was delegated to a Viking Lander Software Systems Engineer (VLSSE). This software systems engineer played a dual role in that he supervised the configuration management of the Viking Lander software in Denver, Colorado, and later supervised the configuration management of all Viking project software at the Jet Propulsion Laboratory in Pasadena, California. This SSE and his staff were primarily responsible for implementing the configuration management disciplines on all Viking software and rigorously enforcing these procedures.

The Viking Lander software which was designed and developed by Martin Marietta in Denver was initially tested in Denver to demonstrate that it satisfied the software requirements. This Denver test was designated as a certification test.

After the successful completion of the certification test, the Lander software programs were taken to the Jet Propulsion Laboratory (JPL) in Padadena, California where they were put through a user's acceptance test.

After the successful completion of the user's acceptance test, the Lander software programs were submitted to the Data Systems Integration Group at JPL where they were put through integration testing. During integration testing, the Viking Lander and Orbiter software was integrated into the Mission Operations Software System (MOSS).

During all of these scheduled tests, certification user acceptance and mission integration, the software programs had the configuration management disciplines imposed upon them.

III. CONFIGURATION MANAGEMENT

Configuration management is a discipline of applying technical and administrative direction and surveillance to three elements. These elements are: Configuration Identification, Configuration Control, and Configuration Status Accounting.

On the Viking project, the elements of configuration management were applied as follows:

A. Configuration Identification

Configuration identification is the establishment of a baseline from which configuration (change) control can be imposed.

For software, configuration identification required the establishment of a baseline on:

1. The Computer Program Development (CPCI-Part I-B5) Specification.

2. The Computer Program Product (CPCI-Part II-C5) Specification.

Note: The formal release of these specifications after approval baselines these documents and places them under formal change control.

3. The CPCI that consists of a tape or disk pack and program listing. Baselining of the CPCI is accomplished prior to the start of formal testing by:

   a. The successful completion of checkout and debugging of the CPCI by the cognizant programmer.

   b. Identifying the CPCI with a unique version identification number both internally and externally.

c. Preparation of an inventory list (or equivalent) that specifies the version of the CPCI and all related software documents. This inventory list is the packing slip for the software inventory package being baselined.

d. By placing the software inventory package in the Program Support Library to prevent unauthorized access or changes to the baselined CPCI after acceptance by a test readiness review.

B. Configuration Control

Configuration control is the evaluation, coordination, and approval (or disapproval) of changes to an established baseline.

For the software end product, this is achieved by the following:

1. All proposed software changes were formally approved by the cognizant program change authority prior to their incorporation.

2. The baselined CPCI and the program listing were requested from the program support library by the software programmer making the approved change.

3. The program support library placed the data from the baselined software program into the computer and provided the program listing to the programmer. This created a working copy of the baselined tape (or disk pack) to be used by the programmer for changes. The original baselined tape (or equiv.) remains active in the program support library until superceded by a new baselined version of the software end product.

4. The programmer makes the changes to the program and after testing and acceptance of the changed program by software quality assurance, the changed version of the program is put on tape (or equivalent), reidentified with a new version number, and placed in the program support library. The previous version of the program is placed in a history file in the program support library.

5. Baselined documents that are affected by changes made during formal testing may be red-lined during the actual test, however, these documents must be formally updated at the completion of the test and prior to the acceptance of the software test report.

C. Configuration Status Accounting

Configuration status accounting is the recording and reporting of the information that is needed to manage configuration effectively. This

shall include a listing of the approved configuration identfication, and the implementation status of approved changes.

The following items are required for software configuration status accounting:

1. Configuration Identifiers - Each computer tape or disk shall be uniquely marked with an identifier both internally and externally.

2. Each patch deck shall be uniquely identified and traceable to its related listing.

3. A listing produced from a tape or disk shall be uniquely identified and traceable by its identifier to the deck or disk and version from which it was produced.

4. Any change to the contents of a tape or disk is a change in its configuration and shall be reflected in a corresponding change to its configuration (version) identifier.

5. Traceability of software changes shall be achieved as follows:

   a) Any change to a tape or disk shall be traceable to specific instructions and/or data that were changed (added, deleted or modified) by identification of the affected items on its related program listing.

   b) Each patch to memory shall be traceable to the memory location it changes, and to the previous and new contents.

   c) Each patch deck shall be traceable to the tape or disk pack (and tape or disk pack versions) it patches and to the problem it corrects.

   d) Changes to the source program shall be identifiable in terms of source instructions removed and added, their positions (sequence numbers) in the source program and on its related program listing.

6. The preparation and approval of a version identification listing (or equivalent) by the PSL constitutes acceptance of the CPCI by listing all approved changes, and the authorized sign-off signatures for change acceptance.

THE COMPUTER PROGRAM CONFIGURATION ITEM

The Computer Program Configuration Item (CPCI) consists of a tape or disk pack and a program listing.

The tape or disk pack is the repository for all of the computer program data and provides the means by which the computer program is placed into a computer to perform its intended function.

The program listing is generated when the computer program is placed in the computer and provides a complete detailed list of the computer program that is on the tape or disk pack.

The CPCI is a part of an inventory of software items which are baselined to implement configuration management. This inventory includes the computer program development specification (CPCI Part I-B5), the computer program product specification (CPCI Part II-C5), the user guide, and all other documentation related to this CPCI version.

On the Viking project, the software inventory package which contained the CPCI version, was assembled and submitted at test readiness reviews for each major test milestone; certification tests, user's acceptance tests, and mission integration tests. When the test readiness review board accepted the submitted software inventory package, it was placed in the Program Support Library (PSL) under the control of the software quality function.

After the successful completion of each scheduled test, the revised CPCI was accepted along with a record list of all changes to the CPCI and all related documentation. This new version identification list was signed off by the software quality function to provide a status accounting record.

V. PROGRAM SUPPORT LIBRARY

To provide configuration management that will be acceptable to the customer, it is mandatory that the configuration management of software be under cognizance of a quality assurance function. A Program Support Library (PSL) under the supervision and control of the quality assurance function is the means by which this is accomplished. The Program Support Library provides support for software configuration management by rigidly enforcing the procedures that provide for the identification, control, and status accounting of the CPCI and its related documentation.

On the Viking project, the program support library at the Jet Propulsion Laboratory was part of the Data System Integration group which provided the implementation and enforcement of all configuration management procedures under the supervision of the Viking project software system engineer and his staff.

VI. SUMMARY

The successful achievement of software configuration management, on the Viking project, was dependent upon the rigorous application of disciplines,

Software development and documentation schedules were established to provide the visibility of schedule performance for software development which was normally apparent for hardware development.

The Viking project software system engineer and his staff established, implemented and effectively enforced all of the procedures for the following configuration management elements:

Configuration Identification established by:

1. The unique identification of the CPCI version to provide a baseline from which change can be imposed.

2. The formal release of the computer program development specification and the computer program product specification, and other software documents related to the baselined CPCI.

Configuration Control achieved by:

1. Placing the baselined CPCI under the control of a program support library to prevent unauthorized access to the software end product, and to protect its integrity.

2. Formal approval of all changes prior to incorporation.

3. Reidentification of a new version of the CPCI after it has been changed.

Configuration Status Accounting is achieved by:

1. Preparation, approval and issuing of the version identification list (or equivalent) to specify that the approved changes to the CPCI and its related documents have been correctly incorporated and accepted. This acceptance authorization is normally provided by a software quality assurance function.

The successful procedures for Viking software configuration management have been adapted for use on current software development projects at Martin Marietta Aerospace, Denver Division.

For additional information relative to this presentation, Johm Campbell may be contacted at:

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LIST OF ACRONYMS

CPCI	-	Computer Program Configuration Item
JPL	-	Jet Propulsion Laboratory, Pasadena, Calif.
MOSS	-	Mission Operations Software System
PSL	-	Program Support Library
SCM	-	Software Configuration Management
SSE	-	Software System Engineer
VLSSE	-	Viking Lander Software System Engineer

8 March 1978
UPDATE (5/79)

DEPARTMENT OF DEFENSE DIRECTIVE

CONFIGURATION MANAGEMENT STANDARDIZATION PROGRAM
(CMAN)
PLAN

Presented by:

JOHN J. DURANTE
Marine Corp

On behalf of:

RICHARD L. BERRY
Naval Material Command

JDCMC MEMBERS

NAVY (CHAIR)	MR. RICHARD BERRY (MAT-042)
AIR FORCE	MAJOR 'DUSTY' RHOADS (AFSC-SDDS) (EXEC. AGENT FOR HQ USAF-LGYE)
ARMY	MR. JOHN BEACHBOARD (DRDME-DE) (ALTERNATE FOR DARCOM-DRCDE-E) (HQ. ARMY STAFF FOCAL POINT-DAMA-PPM)
MARINE CORPS	MR. JOHN DURANTE (MC-LMO)
DLA	MR. ELI LESSER (QES)
DNA	MAJOR HERMAN JONES , USA (LGSS)
DCA	MR. TED MALINOWSKI (513)
NSA	MR. HANK TREMPER (R43)
(DMSSO	MR. SAM P. MILLER)

PURPOSE:

PLAN

- MANAGEMENT OF CM PROGRAM.

PROGRAM

- STANDARDIZE THE CM DOCUMENTS.
- ELIMINATE NEED LIMITED COORDINATED/ SERVICE PECULIAR CM DOCUMENTS.
- PROVIDE BASIS FOR COST EFFECTIVE IMPLEMENTATION OF CM.

SCOPE:

- OVERALL ASSESSMENT OF CM DOCUMENTS:
  - REGULATIONS, INSTRUCTIONS, ETC.
  - STANDARDS
  - SPECIFICATIONS
  - DIDs
  - DARs
- ASSIGNMENT OF TASKS & RESPONSIBILITIES.
- PROVISIONS FOR TAILORING/APPLICATION.
- PROVISIONS FOR MONITORING.

BASIC PROBLEMS:

- GUIDANCE FOR COST EFFECTIVE TAILORING AND APPLICATION FOR EACH PHASE OF THE LIFE CYCLE.
- OVERLAPPING, CONFLICTING, OVERLY RESTRICTIVE & INADEQUATE REQUIREMENTS.
- COMPREHENSION OF CM. Need to identify in front end of program.
- EFFECTIVE INTEGRATION OF CM WITH OTHER DISCIPLINES. Such as ILS and software.
- STANDARD CM TERMINOLOGY & DOCUMENTATION.
- EFFECTIVE MANAGEMENT OF THE PROGRAM.

OBJECTIVES

Accomplished:

- PLAN APPROVED BY OUSD (R&E), 8 MARCH 1978
- CMAN AREA ASSIGNMENT ESTABLISHED, 1 JAN 1977 (SD-1)
- DOD-STD-480A PUBLISHED, 12 APR 1978
- NOTICE-1 TO DOD-STD-480A (TAILORING APPENDIX) PUBLISHED, 29 DEC 1978
- NOTICE-2 TO MIL-STD-483(USAF) PUBLISHED, 21 MAR 1979
- DOD DIRECTIVE 5010.19 COORDINATED AND SUBMITTED TO SECDEF FOR SIGNATURE, APR 1979

Planned:

- IMPLEMENT THE PLAN
- UPDATE THE PLAN EVERY 18 MONTHS

PROCESS TO IMPLEMENT THE PLAN

- DMSSB/OUSD (R&E) TO APPROVE AND DIRECT (MEMO) THE IMPLEMENTATION OF THE PLAN (DMSSO MEMO OF 9 JUNE 1978)
- PROMULGATE THE PLAN (CNM LTR 0423/RLB OF 14 JULY 1978 & 28 JULY 1978)
- PREPARING/PARTICIPATING ACTIVITIES TO COMMENCE TASK REQUIREMENTS
- JDCMC TO:
  - REVIEW PROGRESS
  - PROVIDE GUIDANCE
  - REVIEW/CONCUR PRODUCTS PRIOR TO FINAL APPROVAL/IMPLEMENTATION
  - IDENTIFY/REQUEST CORRECTIVE ACTION
  - PRESENT UNRESOLVED PROBLEMS TO DMSSO FOR RESOLUTION
  - REVIEW/UPDATE PLAN AS REQUIRED (MIN. 18 MOS.)

MILESTONE SCHEDULE FOR PRIMARY CONFIGURATION MANAGEMENT DOCUMENTS

TASK IDENT	PA	TITLE	CALENDAR YEARS 1978 Qtrs 1	2	3	4	1979 1	2	3	4	1980 1	2	3	4
CM 01	DDRE	DOD DIRECTIVE 5010 19. CONFIGURATION MANAGEMENT Started 3/77 Signed 1 May 1979						E1						
CM 02	NM	DOD CM STANDARDIZATION PROGRAM PLAN Started 9 76							E					
CM 03	ASPR COMM	ASPR REVIEW AND DEVELOP PROPOSED CHANGES Started 8 77								E1				
CM 04	NM	DOD CM REGULATION Started 1 78 4130.1								E1				
CM 05	10	CM PRACTICES FOR DEFENSE MATERIAL ITEMS DOD STD XXX (Started 1 73								E1				
CM 06	10	CM PRACTICES FOR SYSTEMS EQUIPMENT MUNITIONS AND COMPUTER PROGRAMS. MIL STD 483 Complete 11 80												E1
CM 07	AR	CONTRACTOR CM PLANS. MIL STD 1456								E1				
CM 08	ASPR COMM	ASPR UPDATE (DAR)						S1			E1			
CI 01	MI	SPECIFICATIONS PREPARATION. MIL STDs 490 AND 961 AND MIL S-83490 (Started 6/77)				E				E1		?		E2
CC 01	AS	CONFIGURATION CONTROL ENGINEERING CHANGES DEVIATIONS AND WAIVERS. MIL STD 480 Started 3 73)		(12	APR	78)								
CC 02	AS	CONFIGURATION CONTROL ENGINEERING CHANGES DEVIATIONS AND WAIVERS. DOD STDs 480A & 481A		S				E						
CS 01	OS	CONFIGURATION STATUS ACCOUNTING. DATA ELEMENTS. AND RELATED FEATURES MIL STD 482A Complete 11 80						S						E
CA 01	13	TECHNICAL REVIEW AND AUDITS FOR SYSTEMS EQUIPMENT AND COMPUTER PROGRAMS. MIL STD 1521A Complete 11 80						S						E

AIR FORCE LESSONS LEARNED

MAJOR LANCE NESBITT
Air Force Acquisition, Logistics Division
Air Force Logistics Command
Wright-Patterson Air Force Base

NOTE: This paper was transcribed from a recording of the session.

Good afternoon, Ladies and Gentlemen. Before I get into the "Lessons Learned" briefing, I want to offer a brief explanation: Last night and today, talking with some of you, I found that a lot of you are not familiar with Air Force Acquisition Logistics Division. So, I would like to take about a minute or two and explain our role in life. We'll be three years old this July. Being logisticians, we were formed as an organaztion under AFLC. We are assigned to new programs to ensure that the logistics needs are identified and satisfied when we buy new systems and field them. Basically, we obtain our information through feedback from our operators, maintenance personnel, and other supporters of current systems. Thus we have incorporated "Lessons Learned" as part of that feedback process.

"Lessons learned" is a frequently used term. The definition, whether applied to a technical or to a management lesson, has two important elements: First, it is recorded; and, second, it has been determined to be an experience of value to future programs. Lessons learned is not any application of individual experience, but rather a process by which we are documenting the results of evaluating the hardware and support planning of current systems and programs. By applying these documented experiences, we can avoid the mistakes of the past and carry forward the things that we have done right.

After a short description of the purpose of this briefing, the methods used in our lessons learned process will be discussed. We draw lessons from a variety of sources and these will be outlined. Our experience in the lessons learned business has shown us what lessons can do. In most cases, it is very significant.

The following is a discussion of the current activity in applying lessons. Our major conclusions from a little over two years in operation will be discussed also. The briefing concludes with a discussion of what is needed to fully institutionalize the application of lessons learned and why we are here today.

In our effort to analyze and evaluate the potential lessons learned and identify the root causes of current performance and supportability problems, we have encountered areas that frankly have surprised us. For example, the radios on the F4 aircraft were a widely publicized lessons learned within the Air Force. All our data systems showed that the seat had a low reliability, when really it was the radio that we were getting after. While lessons of that significance are not documented every day, we have documented other major lessons. This briefing seeks to highlight some of these areas and point out the benefit in applying these lessons.

Now that our process has been through the new organizational growth pains, (as I have said we are a little over two years old), our file covers a relatively broad base of hardware and management lessons learned. We are confident that expanded use of the ALD file can yield both cost and supportability benefits. We strongly advocate the use of our service in the acquisition process within the Air Force.

Simply stated, the method we employ in our lessons learned process is merely the classic functions used in any information process. Drawing from both internal and external sources, we have established a formalized process to identify or receive, analyze and evaluate, and both store and disseminate lessons learned. While we do publicize internally within the Air Force through abstracts of what lessons are on file and publish quarterly bulletins, the most beneficial product to a program decision-maker is a pre-sorted tailored package of lessons learned that apply to his program.

In short, our method is nothing unique, but what is unique is that we have a Directorate organization within the ALD dedicated to a continuing lessons learned function. Another somewhat unique feature is that we have developed a process to provide orientation to the potential users of lessons learned. Our format, key word system, and capability to quickly assemble a tailored package covering a particular subject area or program phase are all geared to recognize that, in a pressure-packed environment of a program office, the Deputy Program Manager for logistics and other decision-makers don't have the luxury of time to seek out lessons that can be applied. We said this is nothing new as far as lessons learned. All programs publish reports and this sort of thing. The problem is that they are untimely for other programs--they get read, filed in "file thirteen" or put in somebody's drawer and forgotten. That's the difference.

Our original guidance for the lesson learned system was that no new reporting system external to the AFALD would be created. Our experience has confirmed that existing sources do provide ample information to use in extracting lessons learned. We have certainly experienced no shortage in source material. We've have all sorts of additional sources within the Air Force and we are hoping that maybe industry will also become a source for our lessons learned.

One of our best sources has been our our field visit program. Using teams of from four to six people, we visit base level activities supporting current systems. We talk to maintenance technicians and supervisors to get their firsthand experience and suggestions for improvement to future systems. In addition to our equipment technicans from the lessons learned activity, the visiting field teams may include individuals from our ALCs System Management activities, Item Management activities, and our Systems Command Engineering communities. Command reaction to this program has been good and, thus far, visits have been conducted on A-7, C-130, FB-111 Simulators, 810, P-38, P-37, B-52 and most recently the F-15 which we are just compiling. Reports of these visits have been prepared and distributed, but the individual lessons are also filed for use in preparing tailored or program-phased packages of lessons learned.

Many lessons learned documents have been published by program offices at specific points in time. We use the lessons recorded in these sources and make sure that they are retained for future use. For example, the F-15 Program Office published an excellent logistics lesson learned document in the spring of 1977. Our action has been to make sure that this valuable feedback information is not lost as time progresses and the initial distribution copies are filed away.

The AF/ALD Deputy Program Managers for logistics are another source of lessons that we capture through yearly reporting. This was instituted to make sure that valuable lessons did not dim during the several years that many acquisition programs take. Inspection and audit reports are also another valuable source of lessons routinely received for lessons learned screening.

Internally in our lessons learned organization, we initiate various projects to look at the product performance capability currently being experienced by operational systems and report it to our existing data systems. For example, we routinely look at high cost logistic support items to see if these items reveal lessons learned. Several of the lessons I will highlight later in the briefing resulted from this particular type of efforts.

We have also sponsored several lessons learned conferences to look at specialized areas such as fuel leak problems, erosion, NDI, and things of this sort. Through the publication of our lessons learned abstract, we've established a cross feed with other organizations in recording lessons from acquisition, engineering, and test activities. We draw from these excellent specialized sources also. None of these activities have been as comprehensive as our efforts and thus serve to complement rather than duplicate our efforts. Utilizing numerous organizational sources helps us produce a useful product. In the case of lessons learned, the value of the product is in its application.

Next I'll describe some of the things lessons learned can do if they are applied. Application is truly the bottom line of the entire program. The use of proven technology as a lesson learned is not to dictate design or hinder advance, but, in some cases, we do attempt to solve nonproblems. We can avoid future cost by recognizing the needs of supportability today. We also tend to support systems in the same fashion as previous systems, because that is the traditional way we have done business. Now may be the time to challenge these traditional ways. Lessons can also identify problems that recur from program to program, and there are a lot of those. There have even been cases where the Air Force induces poor performance by using a proven component in a different location and environment. Our mission needs are paramount and systems must support those needs. But lessons learned can point to areas where system features that are stated as requirements can be challenged.

Sample lessons are the best way to illustrate these points so those will be what I address next. Virtually every new aircraft has tried a different internal fuel tank sealing technique. Various chemical sealants and application techniques have been tried, but nearly every system has had fuel leaks. And these leak problems have had an impact in both readiness and availability. In the base level maintenance environment, repairing fuel leaks is a major maintenance task when the tank has to be opened. After defueling, purging, and moving the aircraft to the fuel cell repair area, removing the old sealant and applying new is a time consuming task and a significant contribution to our maintenance costs. Looking at the cost per flying hour associated with leak repair, our engineers hosted a Lessons Learned Conference on this particular problem area. The use of blind fasteners in fuel areas and the instability of various chemical sealants were identified as problem areas. The significant lesson was that the F-106 and F-102 aircraft had a successful sealing technique using a thermal setting bond sealing system of 1950 technology. This system, known as Scotch Weld, avoids the problems of unknown chemical sealants. While application to ongoing programs may be difficult, certainly no new aircraft program should be undertaken without full consideration of this major lesson learned.

Another management lesson learned was identified in a program where the contractor's claim of proprietary data rights was not challenged while still negotiable. As a consequence, when the need arose to modify the aircraft at a later date, we were in a weak position to require the necessary data to use in engineering the modification. While all proprietary claims cannot be avoided, close attention and challenge can keep this to a minimum.

One of our data analysis projects involved looking at high logistic support items. Many of the top Air Force support cost items are associated with our fire control system. We found a high technology system that had comparatively high reliability also. Many of the major line replaceable units used were changing configuration as the contractors and program officers sought to further

mature the system, a normal occurrence in avionic systems, but a high contributor to support costs. As we dug deeper into the high support cost question, we were led to to look at the economics of the intermediate level of support. We found that the avionics shop reparability is very costly and that the way the components of shop replaceable units are packaged may contribute to high support costs. In short, while automated test equipment is almost a necessity for digital avionic systems, the cost of the test stations themselves may more than offset the cost of additional spares, if we would use a two-level rather than a three-level support concept.

We have traditionally assumed that if reliability can be driven up, both support costs and corresponding life cycle costs will decrease. What we are seeing, however, is that even with better reliability, the cost per hour is high. When the cost of initial acquisition and recurring support costs for the AIS test equipment are considered, we find that life cycle costs are also increasing. While we are still wrapping up our work in this area, we find that the traditionally assumed performance cost relationships may not be rigid, having several variables that can impact the actual experience attained. Packaging of the system should be fully considered. If higher cost integrated system LRV's are designed, higher reliability may not offset the higher cost accrued when the less frequent failures occur. We also need to do a better job, considering all the elements of life cycle costs, in selecting our maintenance concept. We may now be at the point where we should buy more spare LRB's instead of intermediate test stations for each base maintenance activity.

As our skills in the base level maintenance activity decrease, the quality of tech orders takes on even greater importance. Yet we find that most programs experience problems in technical order development. Technical order preparation requiring labor-intensive effort by the contractor has also driven the cost of technical orders up. Pressures in the contractors organization often foster a weak validation effort. New forms of technical order presentation, such as job guide manuals, also require more detailed instructions and more pages of tech orders. This adds to the complexity of the Air Force verification of the data prepared by the contractor and, as a consequence, the magnitude of the verification effort is traditionally underestimated. The realization that we're behind in the TO Program creates pressures to use prototype equipment for verifications and validation with a result that many changes are needed when the TO's are first used in the field. These are several lessons in this area. Our package of Tech Order Lessons learned has been requested more frequently than any other package, which points out the complexity and recurring nature of these problems.

The Air Force has emphasized maintainability for a number of years, yet accessibility continues to be a problem area that we encounter on field trips. Lessons learned in this area will certainly be no panacea, as space limitations will continue to dictate trade-off during the design process. But lessons learned can sensitize this process to the more obvious areas such as components requiring repeated service in inaccesible locations. Lessons learned can draw attention to these areas during design reviews and be used in developing criteria for systems specifications.

It seems only logical to avoid inducing problems when using Government Furnished Equipment (GFE). But we recently encountered some lessons learned which should cause a more critical look at such components. On our simulator field trip, we encountered several flight simulators with complex and costly motion bases to provide attitude changes in the simulator. With the use of the motion system as a command option, some of these systems are not being used. With the visual systems in use today, motion systems may not be necessary for training needs. While there may not be a consensus among the commands on this issue, future simulator programs should challenge any requirements for a motion base system. In other words, make a conscious decision and identify the requirement.

The preceding examples have illustrated some of the many lessons that we have on file and that are available for decision makers. At this time, we have somewhere around 650 lessons in our data bank and it is growing at about 50 lessons a month. In the next segment of my briefing, I will summarize what is available in the file, who is currently using these lessons, and how they are being used.

Very candidly, I can state we haven't beaten the drum too loudly in the past because of the relatively low number of lessons available. Our file has grown to a broader base which expands application opportunities. We do have a backlog as a result of adding new sources and our high level of activity. In the rework group, we also sent a number back to the project offices as a result of our review process. Our goal is not a large number of lessons, but objective lessons that address the root cause of a problem. For specialized engineering assistance in evaluating potential lessons, we have established working contacts with our ASDEN engineers. They have been particularly helpful in pointing out areas that need to be considered in the evaluation of particular lessons. We also seek specialized assistance from our own engineers and other speciality areas such as procurement, contracts, etc. As we add to our file, the base is expanding, but we are also encountering lessons that modify what is currently on file. We have provided packages of lessons learned to Program Offices on both a requested and unrequested basis. Our abstracts have also triggered a number of requests for packages of lessons. We have provided a number of packages of lessons learned to our Deputy Program Managers for Logistics and ELSO activities for application to the programs on which they are working.

SESSION 2

Chairman: RICHARD R. BARTA
IBM Corporation

Secretary: JOSEPH J. O'CALLAHAN
Avondale Shipyards
Incorporated

There have been some recent regulations published within the Air Force, in Systems Command, and in AFLC that also emphasize their use of the file at key points in their programs. For example, the Systems Command regularly requires a program manager to come to us at two points in his program--the conception and validation phases --for program-tailored packages. He must then identify which lessons he has used, those that he hasn't, and be able to explain why these were not applied to his program. We have also used lessons in preparing inputs to program documentation and in the preparation of various directives. The individual specification writers in Systems Command have also become good customers of our file. The incorporation of the lessons learned section in new handbooks, which support the new Mil-Prime-Specification concept, should further increase this activity.

In describing the file, I've already mentioned most of the hows, directive specifications, and program management decisions. What we can't define is the degree of use and whether important lessons are being applied. Obviously, not every lesson can be applied. There will be trade-offs. But a decision not to apply should be just that--a conscious decision. The majority of lessons learned activity in the Air Force is publicity oriented. This is a process where lessons are documented and published in the hope that they will go to the right individual and be applied. We think that it is important to assess the value of the feedback process and to make sure that we are benefiting from our experience. We have willingly provided packages to any requesting agency and we offer assistance and in the application of the programs, but we have had relatively little feedback of applications. Part of the answer lies in the awareness and the ability to get the information to the right place at the right time.

This leads to our conclusions from our effort at this point. The number of ongoing programs at any given point in time, and the various phases and program schedules, make the coordination of the decision and feedback process a complex task. Decisions where lessons can be applied are not daily occurrences, but the decisions, once made, cannot often be changed when a lesson is discovered later. Many of the lessons may be applied solely through action to publicize the information. From the examples shown earlier in the briefing, however, there are significant lessons that should be considered by the senior managers in the program; the application decisions need to be made visible. Both of these conclusions point to actions necessary to fully benefit from our investment in the lessons learned process. This brings us to what is needed now.

We in the ALD are strongly convinced that the use of lessons learned should become an integral part of doing business in acquisition programs. We do see evidence that we in the Air Force are collectively moving toward that goal. For example, we have recently incorporated a lesson learned review into the AFLC modification

approval process, whereby we advise configuration control boards of lessons learned that could apply to a proposed modification. We will also seek to capture lessons learned from this process.

Two other new areas are the previously mentioned Systems Command (AFSC) Lessons Learned Program and the Air Force Feedback Work Group. While the Systems Command program is just being developed, it is compatible with, and complementary to, our efforts. The Feedback Working Group is the one that developed the Air Force regulation that is ready to be published on feedback and is much broader in scope than just lessons learned. These efforts illustrate that management attention is being focused on lessons learned application, but publication of directives will not ensure that decision-makers are motivated to apply lessons learned. In particular, major lessons, like fuel sealing methods, planned support concepts and objective challenges of requirements must be both emphasized by, and visible to, top management. In short, both the decision process and programs, and the executive reviews of programs, should focus on full considerations of lessons learned in reaching decisions and, in effect, imbed lessons learned in the decision process.

That brings us to why we were invited here. Our Commander, General Albert, recently sent a letter to ADPA and offered our lessons learned file to industry. Some of you have already seen a pamphlet on how to contact us and the key words we use in retrieving our lessons learned. You can contact us in our office. We would appreciate first-time contact by letter specifying the particular areas of interest. We will respond with copies of our lessons learned. One thing I ask, please do not be too critical. Remember for whom these lessons were originally being made. Sometimes our English, the way we state things, may not be the correct way of doing this in a good publication. Our management lessons learned are, in many cases, very mundane. They basically tell the guy, "Hey! Plan and execute", and this must be done right from the beginning of your program, all the way through. We found that our managers don't have this experience and these things need to be pointed out to them time and time again. So, in these areas, those of you who have been in the business for many years may think, "Hey! That's no lesson learned." But believe it, it is to many of our people in the acquisition business. If any of you have questions, please give us a call and we will be happy to work with you. Our telephone number is (513) 255-3222 or -3885. Thank you.

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE ACQUISITION LOGISTICS DIVISION (AFLC)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

27 April 1979

General Henry Miley, USA, Retired
American Defense Preparedness Association
819 Union Trust Building
Washington, D.C. 20005

Dear General Miley

The Air Force is dedicated to positive action which will increase availability, supportability, and readiness of Air Force systems, while minimizing life cycle costs. Application of experience gained from our deployed systems is essential in the accomplishment of this objective. Prior to the formation of AFALD, a formal mechanism for capturing, storing, and disseminating logistics experience from the field to the designer did not exist.

We are building a comprehensive system to provide feedback from the flight-line mechanic, product division, and experts at the contracting facilities to the designer or to the support planning decision maker. However, we recognize that application of lessons learned is the essential element. The key to this is getting into the acquisition process early and getting lessons learned to those who influence and produce design concepts, namely, you the contractor.

In order to improve and broaden the application of lessons learned, we have opened our file to the defense industry. The attached key word listing contains the terminology used by the AFALD/PTQ to index and to retrieve its lessons learned. It was prepared to illustrate the scope of subjects that we currently have on file and how you can access this information.

Our lessons learned are filed in the form of a concise, one-page summary which can be disseminated to our users. This summary includes a topic, the lesson learned, a statement of the problem, a discussion of the example situation, and suggested actions to be taken in the future. By use of key word indexing, we are able to cross reference by system, subsystem, and equipment. Currently, the data is accumulated and stored manually with this key word capability. We can easily shift to an automated storage and retrieval system at a later time.

We invite contractors to request tailored packages of lessons learned based on your areas of interest. If you need more information on our process or the repository, our commercial number is (513) 255-3578. People who can help are: Ms. Jeanne Zekowski or Ms. Lana Bailey, AFALD/PTQS.

Sincerely

JOHN G. ALBERT
Lt General, USAF
Commander

1 Atch
Retrieval and Indexing Terminology

ENGINEERING DRAWING PRACTICES DOD-D-1000B and DOD-STD-100C

by

M. E. TAYLOR

Army Armament Research and Development Command

ABSTRACT

This paper provides an overview of the current activities on Specification DOD-D-1000 Engineering Drawings and Associated Lists, DOD-STD-100 Engineering Drawing Practices and DRPR Standardization Document Program Plan.

The subject of engineering drawings is of significant interest to most of this audience as drawings are the primary element of engineering documentation. Most of what I have to report has been discussed in part at various previous sessions and meetings such as last years annual meeting in New Orleans. There are no new and exciting developments to report on. My presentation will be essentially a review of current status and what is in progress for the future.

DOD-STD-100C

The C. Revision of DOD-STD-100 was issued under date of 22 December 1978; however due to delays in final release and reporduction, copies are just now being distributed.

The major changes were:

a. Updating of referenced non-government documents.

b. Provision for metric which is reflected in the change in document number prefix from MIL- to DOD- and inclusion of illustration in metric. Drafting practices are essentially the same in both conventional and metric units.

c. Addition of SCALE requirements which were omitted in the previous issue.

d. Use of IPC-D-350 for printed wiring boards.

e. Addition of list of materials for drawing originals, duplicate originals and reproductions.

f. Special marking for radioactive materials.

g. Revision of numbering of non-interchangeable parts and up assemblies to the practice in the A revision.

h. Reference to Code Ident. completely replaced by FSCM.

i. Several changes to correct errors and inconsistencies.

MIL-D-1000B AM 1

The tailoring appendix was approved and released as amendment 1 under date of 30 November 1978. The guide was developed at a series of government - industry meetings with significant participation by ADPA as well as other interested associations. The guide is intended to improve precision ordering of only the data required and encourage cost effective counter proposal from industry. It is too early to have any significant feedback on the utilization of this document.

DRPR Standardization Document Plan

We are currently developing a Standardization Document Plan for the Drawing Practices Area. This plan, which will be coordinated with industry, will provide the future plan of action for standardization documents related to drawing practices. It is expected that the plan will reflect adoption of additional non-government documents to replace portions of DOD-STD-100, simplify and coordinate the diverse related Data Item Descriptions, and provide some guidance in the emerging technology areas such as micro circuits which are not adequately addressed in the current standards.

You will be provided an opportunity to ask questions and discuss these and related documents at the Drawing Workshop planned for tomorrow afternoon. Comments and suggestions of both DOD-D-1000 and DOD-STD-100 are invited and may be submitted on the DD 1426 form attached to the documents.

SOME SOFTWARE MISCONCEPTIONS (MYTHS) EXPOSED

JOHN D. COOPER

ANCHOR SOFTWARE MANAGEMENT, LTD.

SUMMARY

Several misconceptions or myths about some facets of software have evolved over the years. This paper addresses five of these myths attempting to expose them and put them in their proper perspective. Subject of the myths are Programming Languages, Structured Programming, Documentation, Flow Charts and Firmware.

SOME SOFTWARE MISCONCEPTIONS (MYTHS) EXPOSED

INTRODUCTION

I would like to use the next 20 minutes to tackle head-on five misconceptions, or more appropriately myths, concerning software that are still today bouncing around the industry. Like most of mythology there was a certain amount of truth surrounding the origin of these myths. However, I hope to be able to convince you that they are today a great deal more fiction than fact.

PROGRAMMING LANGUAGES

The first myth to be debunked is that "machine oriented languages are more efficient than high order languages". Assembly languages represent the most common example of machine oriented languages or MOLs. COBOL, FORTRAN, CMS-2 and JOVIAL are examples of high order languages or HOLs.

Figure 1 gives a simple example of a program statement written in an HOL and then shows its MOL equivalent. Note the HOL reads almost like English while on the other hand the MOL is like so much gobbledy gook. Which would you rather read, learn to use, decipher or maintain?

The myth statement was generally true in the very early days of HOLs when the first compilers were often very inefficient and all programmers were skilled in the use of machine code or assembly language. (Efficiency being measured in terms of

SIMPLE EXAMPLE

HOL

IF PAY LTEQ FICAMAX THEN PAY EQ PAY-FICARATE

MOL

```
            ENT*U*(PAY)¢
            SUB*A*L(FICAMAX)¢
            JP*A$$$$$11DW*APOS¢
            ENT*A*L(PAY)¢
            SUB*A*L(FICARATE)¢
            STR*A*U(PAY)¢
A$$$$$11DW  o
            o
            o
```

Figure 1

COMPARATIVE ADVANTAGES

HOL

- o INCREASES PROGRAMMER PRODUCTIVITY
  - EASIER TO BECOME PROFICIENT
  - REQUIRES LESS INTIMACY WITH HARDWARE
  - RESULTING LOGIC IS LESS COMPLEX
  - LESS PRONE TO PROGRAMMER ERROR
  - MORE NATURAL TO USE
  - CAN CODE PROGRAMS FASTER
- o
  - EASIER TO MAINTAIN PROGRAMS
  - EASIER TO READ ANOTHER'S PROGRAM
  - EASIER TO MODIFY PROGRAMS
  - POTENTIALLY SELF-DOCUMENTING
- o ENABLES TRANSFERABILITY OF PROGRAMS
- o MUCH LARGER LABOR POOL AVAILABLE
- o LESS DANGEROUS TO THE SYSTEM

MOL

- USE OF MEMORY CAN BE MORE EFFICIENT
- PROGRAMS CAN BE MADE TO EXECUTE FASTER
- GIVES DIRECT CONTROL OVER I/O AND INTERRUPTS
- CAN CAPITALIZE ON HARDWARE IDIOSYNCRACIES
- EASIER TO CHANGE (PATCH) CODE
- PROVIDES ONE OPTIMIZATION FACILITY

memory utilization and speed of execution.) Today the statement is true only when used by an <u>expert</u> assembly language programmer. Only 5 percent of the programmer labor force is estimated that fall into this category. There just aren't that many programmers around that can out-perform a compiler which was implemented by a real expert. The myth is definitely false when the MOL is in the hands of the average programmer of the industrial labor force.

There is another caveat that must also be applied. Even in the hands of an expert, the myth is only true when the programs are small and highly modular. This is due to the limitation of the human mind to remember and keep track of the myriad of details involved in assembly language programming. Things like the content of all registers at all times, addresses and contents of temporary storage areas, status of various input and output activities, and so forth. The scope of all this type of technical detail must be restricted to small programs in order for the programmer to out-perform a compiler with comparative limitless remembrance.

Have you ever heard of a programmer who didn't think his program was critical to operation of the system or of a program manager who didn't maintain that he was suffering under severe memory and processor time constraints? This sort of rationale is used to justify the use of an assembly language. There is a lot of data to support the fact that both persons are wrong about 95% of the time. For example, a well known rule of thumb says that 5% of the code performs 95% of the work.

There are other reasons too. MOL usage is promoted by contractors because the resulting obscure programs enhances contract security. How can the development be monitored when the MOL code is as unintelligible as that in the Figure 1 example? MOL usage is further promoted by the programmers because his obscure code means job security. There is no way to supervise his progress and, worse yet, there is no way to replace him. No one could ever read or understand his code.

Now let's re-define efficiency in terms of development costs; which is very important since software is so labor intensive. Take a look at Figure 2. The advantages of HOL against MOL's are compared. If you were the program manager, or better yet, the customer, which would you rather be used? The first two MOL advantages shown there have been discussed. The next three are sometime necessities but certainly not valid reasons for writing the whole program in MOL. Finally, optimization is a more ligitimate use of MOL. The proper thing to do is first write the whole program in HOL, then with monitors locate the 5% of the code that's using 95% of the processor's time and then perhaps re-writing that code in MOL may prove cost effective.

MOL's really aren't more efficient than HOL's when all factors are considered. But you would be surprised how many new development projects are still using MOL's. The time is over-due for recognizing the mythology involved and step into today's world of HOL's.

STRUCTURED PROGRAMMING

The next myth says that "The use of Structured Programming results in very inefficient code". Structured programming came along in the early seventies and it encountered the natural phenomenon of the resistance to something new or to change. Also the "this ain't the way we've always done it" syndrome helped to retard its acceptance. Structured programming required some re-thinking on the part of veteran programmers. Inertia was difficult to overcome. The almost universal argument against its use was that it would result in inefficient programs.

Structured programming means different things to different people. Basically it is a collection of good software engineering techniques. It includes not only the use of a limited set of control structures but also other things such as: small and independent modularity; only one entry and one exit per unit of code; use of stubs; use of design and code walk-thru's; and readable code. While these procedures are all very beneficial, the single most important facet of structured programming is the discipline that it introduces into the software development process. Up to this point, software development had been characterized by a lack of discipline. There is a natural tendency to resist a sudden curtailment of liberties, ie. discipline.

Some people were so convinced that structured programming was inefficient that they set out to prove it mathematically. They succeeded too. There's a problem with that though. Structured programming is less efficient only when compared to a

perfect program! I don't know very many people who write perfect programs. Especially the type of contract programmers who are used to mass produce software for the government, I don't believe write perfect programs. I contend then that structured programming does not result in inefficient programs of the type sold to the government.

Actual experience bears me out. If it were really inefficient then no one would be using it, especially the aerospace or defense industry. I don't know of any companies who are not claiming to use structured programming — do you? Almost all government contracts in one way or another require it. The Air Force's Space and Missile Systems Office (SAMSO) and Rome Air Development Center (RADC) have both been specifying its use for a long time. Mil-Std-1679 entitled "Weapons System Software Development" is steeped in structured programming. If structured programming were as bad as some people would have us believe, then it would not have that kind of support.

Even if the good software engineering procedures and techniques were not involved, the disciplinary effect that structured programming exerts over the software development process makes it all worthwhile. During my time in the DOD software business, I never saw a contract that required an elegant or a creative or a heuristic program. They weren't looking for esoteric software, they wanted programs that satisfied the requirements, that worked, that came in within cost and schedule constraints and that were maintainable. Even if structured programming was somewhat inefficient in terms of space and speed, the discipline

would more than counter-balance that and make its use cost effective.

Were you able to think of a company who didn't use structured programming? If you did — I'll bet that in three years from now they won't be in the business of selling software to the government. They can't be competitive in producing their software. It's time that all the artificial resistance to structured programming be dissipated and the business of developing software with a positive attitude be gotten on with.

DOCUMENTATION

A common software related whipping boy or Shmoo is computer program documentation. Too often it is just thought of in terms of the paper, ink, technical writing, typing and publishing. A lot of people, especially the unenlightened, think it fashionable or smart to assert that the cost of documentation is excessive. While a certain amount of that assertion is true, it is certainly not true within the context of their implication.

Documentation also gets a bum rap from programmers. Documenting a program is the last thing a programmer wants to do. He will go to all sorts of extremes to get out of that distasteful chore. They hate to do it. Consequently, they defame it at every opportunity. Their heart is not in their work and, thus, they don't try to do a good job.

Ask yourself what is computer program documentation. Documentation is the physical manifestation of all aspects of a computer program. It is the vehicle for the delivery or a program.

It is the statement of requirements for a program. It is the detailed description of the design of a program. It comprises the baselines for configuration management. It is the vehicle for change control. It is a maintenance tool. It is the operator's manual and the user's instructions. And so on.

If you were not allowed to buy any documentation or you inherited a program that didn't have any, I'll bet you ultimately would be willing (as well as required) to spend a lot of money to obtain this necessary tool for the aforementioned functions. Of all its many uses, some of which were mentioned earlier, let's examine one, program design, in a little more detail. When a large software system is developed, a great deal of effort goes into its design. How is this design committed to posterity? How is the effort charged to the customer? The computer program design specification document is the vehicle for these activities. The developer should formalize the design of a program rather than doing it in an ad hoc manner on the fly, using the back of envelopes. The customer should be willing to pay for the design of his program, remembering that a good design is more expensive than the programming by a factor of at least two. Yet the program design document is nearly always criticized for being too expensive. The cost is not for the paper and ink of which the document is composed, it's for the effort, time, creativity, etc. that goes into the design.

If you examine all the other necessary functions served by documentation in light of their proportionate share of the software development effort and their contribution to the software development and maintenance processes, you will find that they too are not really as expensive as the current mythology would lead you to believe. How much is a good statement of requirements worth? What else would you use for configuration management? Good operator, user, and maintenance documents are worth their weight in gold. Exact values for these services and uses cannot ever be obtained but we know they are not as expensive as the consequences of either poor or missing documentation. They also are all orders of magnitude less expensive when obtained concomitant with the software development process rather than when they must be reconstructed after the fact.

Yet on the other hand, computer program documentation does cost a little more than it should. It is like its attendant computer program - labor intensive. Researchers have long sought the Holy Grail of a better way to document computer programs. Admittedly the English language is very poor for this purpose but at this point it's all we've got. Lacking a better vehicle, we can at least try to reduce the amount of labor (thus the cost) involved by somehow automating the document creation process.

This myth that documentation is excessively expensive must be laid to rest. It is often the cause of some of a

project's problems. It creates the mentality that results in the documentation being the first item cut when the project experiences a budget cut or a cost over-run. Since documentation turns out to be necessary, then that tactic turns out to be penny wise and pound foolish. Good documentation is cost effective.

FLOW CHARTS

The next myth says that "flow charts are an absolute necessity for life cycle maintenance of software". This thinking is similar to that perpetuating some of the other myths - unenlightened. In the early days of the software industry, flow charts were as sacrosanct as motherhood. The myth was given a new lease on life when automatic flow charts came along. Now flow charts could be generated not only automatically but very accurately and cheaply as well.

In some ways the advent of auto-flow charters was the beginning of the end for all flow charts. The first thing the auto-flow charters did was to prostitute the primary purpose of flow charts. Flow charts were originally intended to help a programmer by the use of symbols, to organize the logic flow of his program. He first designs his program, then uses a flow chart to develop the logic flow and then as a final step he codes his program according to his flow chart. Auto-flow charters can't be used until the coding is completed because they work from program source code. Thus, manual flow charts

are still required and the automatic ones are a redundancy. Redundancy is never cheap. Automatically generated flow charts are very accurate - yes, until the code is changed and the program is not completely flow charted again.

Also helping sound the death knell for flow charts was that the automatically generated ones amplified the complexity in their construction and use. The many off-page connectors result in a tremendous amount of page flipping back and forth. This destroys a person's train of thought as well as being a rather large bother.

Perhaps we have digressed. The myth says that flow charts are necessary for the maintenance of software. Recall that a real flow chart is generated prior to coding. The code that represents that flow chart will be changed many, many times before that program is established in its final field environment. Thus, there is no way that flow chart can be used by a maintainer to help him decipher the program's logic and code.

On the other hand, automatically generated, after-the-fact, flow charts faithfully represent the program's logic and code. I wouldn't bet on it! Again, that's only true if the program had been completely flow charted after its last program change. It costs money even for the automatic type of flow chart, not to mention the other logistical considerations of time, bother, configuration management of the flow charts, distribution, etc. The people with the money just don't like to spend it that way.

Consequently, the flow charts get re-done after some arbitrary number of changes in the code, if ever at all. The bottom line is that the maintenance programmer doesn't know whether the flow chart is current or not. He can't trust them.

What good is the flow chart if the maintenance programmer lacks confidence in them and won't use them? They are just a waste of money and effort as far as he's concerned. His job is hard enough without spending hours or even days on some wild goose chase brought about by an inaccurate flow chart.

The flow chart's coup de grace was rendered by structured programming. The structured programming restrictions on logic flow obviated the need for flow charts in the traditional form described by the ANSI standard. There have been six or seven attempts, such as "Chapin Charts", to devise an alternate graphic or symbolic way to represent the logic of a structured program. None so far have gained any significant amount of acceptance. Since every reputable company in the industry is using structured programming, the only requirement for the traditional type of flow chart is an artificial one.

It is now time for the flow chart requirement to be laid to rest. This requirement is a hold over from earlier times and which is being perpetuated by the unenlightened who are reluctant to cut them loose. Flow charts are a big cost driver. In this time of increasing costs of software and documentation, flow charts represent an unnecessary expense that can be done away with.

FIRMWARE

Our final myth is also the most recent one. Mythology has it that firmware is some kind of special, unique beast. As a consequence, all sorts of new procedures and techniques are being discussed and proposed for dealing with firmware. Attend most any of the industrial computer workshops and you will find several panels dealing with some facet of firmware. Some of the topics in vogue are: What is the proper way to document firmware? Are high level languages appropriate for developing firmware? And, is firmware really software or hardware?

What is firmware? Answering this question will go a long way toward putting firmware in proper perspective. First, firmware can be defined as: "The logical code (micro-instructions) of computer equipment which interprets the control functions (microprogram) of that equipment." Within that definition fall two different types of firmware, depending upon the form of their residence inside the computer. One type resides in what is commonly called writeable control store. The microprogram for this type is read into the computer and executed just like any other computer program. The other type of firmware usually resides in a semipermanent form of memory like PROMS and EPROMS.

From that definition, it should be clear that firmware is really nothing but software. It is merely a more primitive form of computer instructions than is normal machine language.

The microinstructions are arranged in a sequence that results in a computer program just like machine, assembly, or high order language instructions. Microprograms are designed, developed, and tested just like any other software packages. In fact, it is developed in the software factory and many of the same tools are used. Firmware is software and it should be treated accordingly.

The only form of firmware that deserves special mention is that type that resides in PROMs. Because of the inflexibility of this form, final testing is more critical. Even this form of firmware is software up until the instant the microprogram is burned into the PROM. After burn-in, it is just like any other item of hardware and should be treated accordingly. It is this type of firmware that has caused the consternation. But really it's software and then hardware, not some special, unique beast.

Due to its rather primitive form, firmware does merit some special consideration. It should not be considered a separate engineering process. It is merely another form of software. The firmware myth is not as deeply entrenched as the other myths. Hopefully it will then be easier to dispose of this one.

SUMMARY

In summary, my goal was to expose five common software related misconceptions or myths and place the attendant notions into proper perspective. Myths and misconceptions survive only in a recondite environment. By bringing them out in the open and examining them critically, their creditability tends to dissipate quickly.

The use of high level programming languages really is a lot more cost effective than using assembly languages. That's why they were invented and why they have survived. The resultant discipline of structured programming has been extremely contributory in reducing the cost of developing software. Structured programming has been the only significant advance in the software state-of-the-art in the last twenty years. Computer program documentation is essential to all aspects and phases of the software life cycle. Its costs are commensurate with its utility and when viewed in that manner, are not especially out of line. Flow charts are a relic from days gone by. They are no longer (if they ever were) useful. To continue to insist upon their creation is just not cost effective. Firmware is not some new mysterious technology, it is software. Once this is recognized, it easily can be dealt with.

Today is not soon enough to remove the mythology from the software development and acquisition processes and get on with the business of producing high quality software in the most economical way.

PRINTED WIRING SPECIFICATIONS AND STANDARDS

DIETER BERGMAN
Technical Director, IPC

NOTE: This paper was transcribed from a recording of the session.

I am very pleased to be here. I was also pleased to see that when I got my rental car, it was not subject to the odd-even thing at the gas station. The IPC is located in Evanston, Illinois and we watch the situation out here very carefully. We had our share of problems this winter, as most of you know. Maybe if our Mayor Berlandi could have done something with the snow as Governor Brown did with the gas he would still be mayor.

Anyway, today I would like to talk to you about MIL-STD-275, covering the design of printed boards; MIL-P-55110, for the procurement of bare boards; and MIL-P-28809, for assemblies.

Before I start on the specifications you should know as most of you do, I work for IPC. We go by the initials IPC which used to stand for Institute of Printed Circuits. A few years ago we changed our name, but kept our initials. The logo IPC was well-known throughout the world in printed wiring applications. They wanted to keep that, but the name is now Institute for Interconnecting and Packaging of Electronic Circuits. We try to avoid using the whole name and just go by the initials. The reason I mention this is that IPC has gotten involved in the interconnection of electronic components. We have committees on hybrids, discrete wiring, back planes, and things of that nature. Because our main forte was printed wiring, we did become involved in the use of military specifications that affect printed wiring boards.

In 1976, the Defense Electronics Supply Center (DESC) called IPC and asked us to work with them a little differently from the way we had in the past to develop changes to the existing printed board specifications. I don't know how many of you are familiar with the way specifications were created, but at that time we used to get a contract from the Government and one company would develop what they felt the Government wanted. This was then circulated throughout Industry and was followed by coordination meetings. These meetings were often three days of continual arguement between Government and Industry members. That was a pretty fruitless kind of activity. When DESC asked if we could do something different, we suggested creating a group consisting of eight representatives, tried and true, from Industry and eight representatives

of the Services. This group would be locked in a room for three days to develop a proposed revision. At IPC, we put together a blue ribbon committee made up of industry experts. They represented the large manufacturing companies (ones that have captive shops), as well as independent manufacturers that supply boards to industry. We got in those eight people a relatively good cross-section of industry. The military, of course, was represented by the Army, Navy, Air Force, National Security Agency, and also the Missile Command.

It was very interesting--you put all these people in a room and took off their hats, and you really couldn't tell who was a Government person and who was an industry person. The exercise was one of "let's see what we can do to come up with the very best concept that would be fair to someone who was buying boards and someone who was making boards." An interesting note is that one of the individuals who was from industry had a completely different attitude. He wanted to do very little testing because he felt that he was a good quality house. When I said to him "Hey, Jim, what if you have to buy boards?", he said, "Oh, then I want this, this, and this." So I guess it depends where you sit.

Anyway, this concept has worked pretty well in revising MIL-STD-275 and MIL-P-55110. We have just finished doing the same thing with the raw material specifications. Some of you may have already gotten copies of MIL-P-13949 which now combines all the raw materials used in printed boards. We are now starting on MIL-P-28809, the assembly document. Although it has existed for several years, it has not been revised in light of the latest changes.

Anyway, back to MIL-STD-275 and MIL-P-55110: This group met, looked at the documents, and decided that we would combine everything that existed for rigid boards into three specifications. A design specification which would define three types of boards; Type 1 being single-sided, Type 2 being double-sided, and Type 3 being multilayer. MIL-STD-275 would contain the design requirements, MIL-P-55110 would cover single, double, and multilayer boards, and MIL-P-28809 already contained assembly requirements for the three board types. So what our industry has now is three basic documents.

What I would like to do this afternoon is go over briefly some of the things that created the most discussion during these meetings. (We met, as I recall, in June 1976 and in December 1976. A draft was sent out to industry early in 1977, a coordination meeting held in mid 1977, and the two documents were released early last year.) In many instances, industry made compromises and the Services made compromises. I would like to give you a little benefit of some of those.

The scope of MIL-STD-275 establishes it as a standard for rigid boards only. (The plan is that at some time in the future there will be a design specification for flexible printed wiring, but for now we're talking only about rigid.) In addition to that, MIL-STD-275 is for rigid boards that are conformally coated after the components have been inserted.

With that in mind, let's look at the content of the document. There are four major sections in this document with which you should concern yourself . Section 4 has the general requirements, Section 5 has the detail board requirements, and Section 6 the requirements for assembly of components.

The document gets right to the heart of the problem in paragraph 4.1 under General Requirements, where it requires that a quality conformance test coupon shall be included on the master pattern, master drawing, and artwork. Now this is new; we really never had to do this before. When we provided the procurement package to the Government with an outline of the board or the circuit configurations, we never had to define a test coupon. The new MIL-STD-275 has two test coupons defined therein; one for single and double-sided panels and the other for multilayer panels. They state in the document that you shall have at least one quality conformance coupon on each panel. Our industry builds panels, not boards. The Government is very concerned that they have some assurance when they inspect a coupon that it is representative of the board.

At this point in the meetings, we got into some discussions about how coupons are normally applied. One member said, "Well, you know we get the artwork, we reduce it, make a master pattern, and and look at it. When that's all pretty good, we get some tape and tape the coupon onto the master pattern and we make our production run." Well if I were going to buy boards and look at the coupon to verify registration, I wouldn't be very happy if it was just taped on. So the statement was put into the new standard that when you create a master pattern, you define where the quality performance coupon shall be. When you are dealing with several vendors this may get a little tricky. Since you don't know how many boards per panel will be built or what the total panel size is, your documentation should be general enough to give him two or three possible coupon locations in relation to your single board image. You need to discuss with your suppliers how they are going to handle the coupon on a panel basis. There is a figure in the new -275 that makes some suggestions, but the basic criterion is that the coupon must be representative of the board that is being inspected.

MIL-STD-275 still talks about the master drawing and says things like, "The size and shape of all features, holes, and lands shall be adequately dimensioned." However, there is a basic new paragraph that has been added. It says that you will specify on the master drawing those manufacturing allowances that you include in the design when you first develop the drawing package. Let me tell you the reason for that.

In our industry, we have the problem where one company had the development contract and the Government had bought ten boards. It would then go to another company for the production quantities, and--lo and behold--the boards couldn't be built from the same artwork. This was primarily because somebody had underdesigned or that the minimum annular ring requirements were not really considered or that the manufacturing allowances considered in the design were not adequate. If you're building boards that you have designed, you can be very careful with a certain set of holes if you know they are a problem to you. The next guy that gets that information doesn't know it, so he starts building scrap. Of course, the Government has to pay for that. As taxpayers, we eventually pay for it. So the new -275 requires you to specify on the master drawing what allowances have been used in preparing the artwork. This lets someone who is reviewing the drawing package for the next procurement look at those notes and determine if his processing tolerances are adequate to build that board.

To determine such allowances, there's a table in the new -275 that say if you are building a panel that is less than 12 inches, you should add (if you're building what they call a "preferred category board") .028 inch manufacturing allowance to a drilled hole. If you're building what they call a "standard board", you add .020 inch and, for "reduced producibility boards", add .012 inch. Then there is a formula to determine if you have the right land size, but you must also consider etching or any other problems. Another subtlety in getting to the required -55110 annular ring is that for two-sided boards, the annular ring is measured from the plated hole, but for multilayer boards, it is measured from the drilled hole. So you get some additional advantage in the two-sided boards as far as making the land as small as possible. I highlight these thing for you only because they must be considered by the designer.

Mr. Taylor mentioned that there is an IPC specification on automated language for printed wiring that has been called out in DOD-STD-100C. It is mandatory in -275, that if you supply a magnetic tape of the computer program to the Government, that the language used to define the board or artwork be in accordance with IPC-D-350. That document was developed by an IPC committee, coordinated with ANSI, and approved for use by the Department of Defense. This is another example of where the Government is starting to use industry documents.

Another item of interest is that although we have talked about datums in the old -275, this time the requirements are a little more specific. You will have two datums on your board; however you need have only two holes to define these datums. (The old standard required three basic holes.)

In paragraph 4.4 of the document there's the statement that talks about the assembly drawing. Now, people will say, "Why are you talking about an assembly drawing in a design document?", but most of you know that the procurement package is made from the design layout. The group that met determined there are certain problems created downstream because things are not documented properly, so in the new -275 you will find a statement that says assembly documentation shall, as a minimum, call out things like:

- o Lead forming (something we never called out before).
- o Cleanliness requirements. (It is of great concern that the boards be clean prior to putting conformal coating or sodium mask on the board because of reversion of the material due to contamination under the various coatings.
- o Location and identification of components. (We've always had component orientation and polarity).
- o Structuring detail should also be documented.
- o Electrical testing requirements, if any.

Then there is a subtle little note that says all appropriate assembly requirements in Section 6 shall be defined. Section 6 has paragraph after paragraph of assembly information detailing mounting requirements.

The group tried to ensure that when a documentation package is developed, the next user doesn't have sixteen thousand questions on what's required or product scrap in the process.

Section 5 deals with the board requirements. The conductor thickness and width are very similar to what they were in prior issues. They still are based on the current carrying requirements. However, we are allowed to go down to 5 mil spacing on the end product board, which is new. We convinced ourselves that this was a good thing to do because multi-layer boards were already allowed to go down to five mil spacing on internal layers. Since we are talking about conformally-coated boards, there is no need to worry about the electrical clearance.

There's another statement in there which may get some of you in trouble. It says that the minimum conductor width specified on the master drawings shall not be less than eight mils wide. Now that's the end product minimum. You can still have nicks and dents per -55110, but I caution all of you that your designers must not suddenly start designing boards where you are attempting to put .008 inch conductors on the artwork without manufacturing allowances. The intent here was that people had been making artwork with ten mils, then you've reduced the line by a couple of thousands and wound up with eight mils. These boards have functioned adequately. They've had no problem. So we've convinced

ourselves that eight mils was a good number to put on the master drawing as a minimum. Don't misinterpret that this is equal to the old .010 inch minimum that used to be there. People misuse that kind of concept.

Comments on interfacial connections are still there. Eyelets, rivets, pins, etc, shall not be used as interfacial connections. Clinch wires are still good as an interfacial connection; however they're part of the assembly and should not be considered as part of the board. If you are doing electrical continuity tests, this may give you a bit of a problem. In the paragraphs on interfacial connections, there is an important statement on solder plugs. Solder plugs have been a very emotional thing with our industry and the Services as to whether the plug is good or whether it's bad, whether the board is more reliable with the plug in the plated holes or without it. Many, many hours and many arguments have taken place on that particular subject.

We had one coordination meeting during which one individual stated that he had data proving beyond a shadow of a doubt that a hole without solder was more reliable than the hole with solder. A gentlemen from the Navy stood up and said, "O.K., keep all the solder out of the holes." Well, we don't want that either. What we want is to stop degrading the board at the assembly level by going back and touching up those holes that didn't fill with a soldering iron--that was the whole concern.

We had many discussions where people would say, "What if I'm building boards with flat packs on them? I have a lot of live holes; what do I do to fill those up? Do I have to go back and solder them?" We all agree the minute you put a soldering iron to the board you have the potential of degrading it a little further. So there's now a new statement in -275 that tries to give us a little edge on soldering. First of all, we said solder plugs are required every place there's a lead and the lead and the hole are electrically functional. That is understandable--you've got to connect the two. A plated thru hole, whether it's functional or not, whether it's got a lead or not, the minute it sees a solder wave it should be plugged, too. Now, the concern there is what if you don't plug all the holes? We hope to resolve that when we get to MIL-P-28809, which is currently being worked on to give some relief (e.g., if out of 2000 holes, three don't plug, it's not a concern--you don't throw the boards away).

During these emotional discussions we finally got to the root of the problem. It isn't so much that the customer wants the solder plug; the lack of solder is an indicator to him that there's something wrong. When boards pass across the solder wave, the holes should naturally plug due to capillary action and the laws of physics. So we made a compromise. We said, "Suppose the boards that don't see the solder wave don't have a plug. Is that all right?" And they said, "Yes, if we have some assurances that the

copper is good." We, therefore, added a requirement in MIL-D-55110 that a coupon be solder shot for two-sided boards and microsectioned to give assurance that those two-sided panels were really good. We hope that this will be of benefit to user and vendor alike. We don't have to go back and touch up all these separate holes with a soldering iron.

I don't know how many of you have been involved in the discussions regarding whether one should remove nonfunctional lands or not in multilayer boards. We've been involved with it at IPC. We have as many different opinions on that as we have members. I've talked to people who can build boards with them. I've talked to people who can build boards without them. I think it's an emotional preference.

The truth of the matter, in my opinion, is that the only time it becomes a problem is when there are a very large number of layers and the dielectric separation is very thin. Then those posts start to give you a problem. Other than that, it's a preference thing. Yes, people said, "Gee, you've got to inspect more." On the other side of the coin, there are people who say they want to leave them in because the drill is cooler as it is going through; you have less epoxy smear.

After many hours of debate, the new -275 says that nonfunctional lands are required except on ground planes. There is also a note which waives this requirement where electrical clearances dictate that you can't have them. Now, you know, that leaves it up for grabs.

There is a statement in the new standard that says the minimum laminate thinness permitted is .002 inch. Don't be mislead by that--in another paragraph it says that the dielectric separations between two conductive surfaces shall be no less than .0035 inch. The reason that .002 inch minimum was permitted is some people said that they used single-sided thin laminate in such a way (bonding it) that the dielectric separation is met, but they like to use two mil thin laminates. Don't let your designers design you in a pocket where you find that the dialectic separation on a multilayer board is less than .0035 inch.

Another benefit for industry was that we finally agreed to allow the use of 1-ounce copper on the internal layer of multilayer boards. Even that's not real clean. The first buried layer coming in from either outside layer must be 2-ounce. The discussions and the theory behind that says that the 2-ounce has a better locking action for plated thru holes and, therefore, will give you a better guard against the thermal expansion characteristics of the epoxy and improved plating in the holes.

Documentation for printed boards should not call out the kind of cladding that is used. Now, drawings that I've seen have always specified the exact material callout per MIL-P-13949. The callouts define the copper cladding on each side of the laminate. This doesn't give your vendor enough leeway. The new -275 allows for the use of half-ounce copper on the surface. This can give you a finer line definition. My recommendation is to specify only the final copper thickness requirements; leave the copper foil at the option of the vendor. Whether he starts with half-ounce, 1-ounce, or 2-ounce, is really up to him as long as you get the required copper in the plated thru holes and on the surface.

We still have the need for tin-lead plating and coatings and we still have two-part connectors. No card edge connectors are allowed in -275.

Section 6 talks about part mounting, greater stress on cleanliness, as I said before. If approved, you're allowed to have surface lead mounting. Of course, flat packs are surface mounted, but the theory is that if everything is surface mounted (for example, even resistor leads are flattened), you need approval. Perpendicular mounting, when specified, is permissible.

We talked about the compatibility of conformal coating and the solder mask. A buffer material is still required when those parts that are very brittle are coated with the conformal coating.

There is an appendix in MIL-STD-275 that gives you a lot of good design information. It has hole-to-land ratios, conductor spacing, feature location accuracies, master pattern material movement, registration, etc. This table is an update of the original MIL-STD-55640 design requirement table. It's in the appendix as a guide only. However, if you took all those numbers and worked them out in an equation to calculate your minimum land requirement for a particular hole, you would find they approximate the numbers that are in the body of the specification. These numbers were developed by statistical survey; asking people what they used. Basically, that's MIL-STD-275D.

MIL-P-55110 has not had too many major changes; still it had single, double, and multilayer boards incorporated. I guess the real changes are in the testing that you perform during board manufacture. (There are frequent in-process cleanliness tests required.) The Group A Inspection is a sampling plan inspection with most of the requirements for visual layers registration, plating thickness, adhesions, solderability, warp, stress, and that kind of thing. On multilayer boards, there is a requirement that one coupon per panel be thermally stressed and microsectioned. I think that all members of the group wanted assurance that processing variances did not adversely affect a multilayer panel. They felt that a look at the copper, hole, and registration of each panel is essential. Everyone is very concerned that the location of the coupon be representative of the panel.

There is still a Group B Inspection, but no Group C. (This is different from -55110B). Group B is performed once a month on two of the most complex boards of a particular type. It includes cleanliness, bond strength, interconnection, resistance, moisture and insulation resistance, and dielectric ability to withstand voltage. The moisutre exposure will take quite a bit of time. The testing to get the product from the manufacturer into your hands or into the Government's hands has really been streamlined quite a bit. We are confident that what we are doing is going to be representative of a particular product.

One of the biggest concerns, however, in our industry--most controvesial--is the requirement that to build boards to MIL-P-55110, you must be a certified manufacturer. Let me tell you how we got into that situation. The previous -55110 required that when you got a contract to build boards for the Government, before you could start production, you had to build what was called a preproduction sample. What you did was: (1) if you had a contract that had thirty board types you first argued with your DCASR as to which was the most complex type, (2) once you decided that, you built six boards, and (3) tested those six boards to all of the requirements for preproduction testing. If they passed, you had permission to start production. The only problem was that if you were building a two-sided board, testing sometimes lasted four weeks. So you didn't start, although you really did, and you took a risk. For multilayer boards, it took a little longer.

The other thing that seemed unfair about it--a waste of taxpayer dollars--was the fact that if you had a contract for the Army this week and one for the Navy next week, you built another six boards. So we sat down and asked ourselves "Isn't there a better way to do this?" The Services asked IPC if we had any kind of a standard specimen that is representative of the state-of-the-art of what is being built. It just so happened we had the B-25 Test Board. It was developed by a committeeto do some insulation resistance testing.

Let me take a few minutes to describe the test boards. The B-25 multipurpose testboard is attached. The board is about 4x5 inches. It does have a card-edge connector even though the military specifications don't allow it. The reason is that we hope to use it to facilitate testing. There are the three comb patterns. Each of these comb patterns has a different comb size. Comb pattern "A" has a 6-1/2 mil line and a 6-1/2 mil space. Comb pattern "B" has a 12-1/2 mile line and a 12-1/2 mil space, and comb pattern "C" has a 25 mil line and a 25 mil space. The one that is required to do certification testing is pattern "B" with the 12-1/2 lines and spaces. The Services felt that the way the state-of-the-art is at the moment this pattern would be the best basis for doing the insulation, resistance, after moisture, the dielectric withstanding voltage, and other tests. One important thing is that the boards that are tested ought to be conformally coated. Some people are finding that they can't pass these tests

after moisture using uncoated boards, even though the final measurements are made two hours after they come out of the moisture chamber. The comb patterns are part of these tests.

There's a pattern "L" and a pattern "J". Pattern "J" is repeated on the other side of the board; both of these patterns are used for interlaminate dielectric tests. In other words, they're checking the dielectric separation between the holes. These holes are on 100-mil spacing. Pattern "L" is used for terminal pull and there is a similar pattern to "L" on the other side of the board, which is pattern "K". That's a non-plated thru hole used for the terminal pull.

Pattern "R" is used for conductivity testing after thermal shock cycling, 100 cycles from -65¼F to the highest temperature limit for the material, then you check the copper. There are also patterns for peal strenght and solder-mask over bare metal.

After all these months I got a call just the other day from somebody at Sandia Laboratories. He said, "You know, you say in your document -55110 ..." (I don't know why he says it's my document). He says that the specification requires that the copper resistance be no greater than one milliohm per .125 inch of conductor. Further, he says that due to the laws of physics of copper, there isn't enough copper, and lo and behold, it turns out that every place else in the coupons we have a 70-mil conductor except on this particular pattern. So if any of you are doing certification testing and are not passing that test, it's becuase you can't. We are going to try to straighten this out by putting a note under the table saying that when you are using the B-25 board, you can have other number resistance.

The B-27 boards provide test patterns for circuit continuity test, plating and minimum pull test, dielectric strength between layers, plated thru hole structure test, etc. We had not defined the requirements for these boards too well. What has happened is that DESC has asked us to make a master drawing for the B-25 and the B-27 boards. This is now also being circulated and probably sometime toward the end of the year after all industry and the Services agree, you will have some very definite requirements on how these boards must be made.

In the multilayer boards, you are going to have to build a board that has a four mil core, eight mil core, eight, eight and then four with twelve mil prepreg, eight, eight, and twelve to give you a total that's somewhere between 80 and 100 mils. The tolerances on each of these is plus or minus two mils and then the overall master drawing requirements. We are putting all the tolerance on the drawings. If you have any comments on the attached master drawings of B-25 and B-27 send them to me.

That's about where we are with the requirements of -275 and -55110. Sometime this summer we'll have a coordination meeting on the master drawings and the certification requirements, if we in industry are to take that over. There is still the problem of measles to be solved and MIL-P-28809. We are working diligently with the Services on these problems.

Thank you very much for your time and attention.

TABLE I
FEATURE LOCATION CHART

DESCRIPTION	LOCATION X	LOCATION Y
	PATTERN J	
Land equals 0.070 + 0.002 -0.003 inches; 0.046/0.040 inch plated through hole	2.400	0.500
	2.400	0.600
	2.400	0.700
	2.400	0.800
	2.400	0.900
	2.300	0.900
	2.300	0.800
	2.300	0.700
	2.300	0.600
	2.300	0.500
	2.400	0.300
	2.300	0.300
	2.200	0.300
	2.100	0.300
	2.000	0.300
	2.000	0.200
	2.100	0.200
	2.200	0.200
	2.300	0.200
	2.400	0.200
	PATTERN G	
	2.400	*2.1175
	2.400	*2.2175
	2.400	*2.3175
	2.400	*2.4175
	2.400	*2.5175
	2.300	*2.1175
	2.300	*2.2175
	2.300	*2.3175
	2.300	*2.4175
	2.300	*2.5175
	2.400	2.700
	2.300	2.700
	2.200	2.700
	2.100	2.700
	2.000	2.700
	2.000	2.800
	2.100	2.800
	2.200	2.800
	2.300	2.800
	2.400	2.800
	PATTERN K	
Land equals [illegible] + [illegible]002 [illegible] inches; [illegible]124 [illegible] [illegible] hole	1.850	2.500
	1.850	2.750
	1.850	3.000
	1.550	3.000
	1.550	2.750
	1.550	2.500

DESCRIPTION	LOCATION X	LOCATION Y
	PATTERN R	
Land equals 0.070 + 0.002 -0.003 inches; 0.046/0.040 inch plated through hole	0.500	0.000
	0.400	0.000
	0.300	0.000
	0.200	0.000
	0.500	3.000
	0.400	3.000
	0.300	3.000
	0.200	3.000
	PATTERN L	
	1.850	0.000
	1.850	0.250
	1.850	0.500
	1.550	0.500
	1.550	0.250
	1.550	0.000
	PATTERN H	
Land equals 0.060 + 0.002 -0.003 inches	2.400	1.200
	2.400	1.300
	2.400	1.400
	2.400	1.500
	2.400	1.600
	2.400	1.700
	2.400	1.800
	2.300	1.200
	2.300	1.300
	2.300	1.400
	2.300	1.500
	2.300	1.600
	2.300	1.700
CONDUCTOR COMB PATTERNS See Note 4	CENTER LINE OF PATTERN A	
	*3.0625	2.750
	CENTER LINE OF PATTERN B	
	*3.0625	1.500
	CENTER LINE OF PATTERN C	
	*3.0625	0.250
	CENTER LINE OF PATTERN D	
	*3.0625	2.750
	CENTER LINE OF PATTERN E	
	*3.0625	1.500
	CENTER LINE OF PATTERN F	
	*3.0625	0.250

* Off Grid Holes

NOTES:

1. Material to be 0.0625 inches thick per MIL-P-13949, Type (as required to be certified for a given product... see paragraph 4.5.3 of MIL-P-55110), clad with 1 oz. copper, both sides.
2. Plating in holes to be 0.001 inch minimum copper, overplated with tin/lead (followed by reflow) or solder coated per paragraph 3.4.3 of MIL-P-55110.
3. Minimum annular ring requirements are 0.005 inches. Tolerances on all hole locations shall be to achieve minimum annular ring. Pattern G and J holes shall be inspected, and must be accurately located to within 0.003 inches RTP.
4. End product conductor configurations.
   - Unless otherwise specified, all conductors are 0.025 inches wide minimum.
   - Patterns A & D each consist of 81 conductors, for surface insulation resistance testing. Their end product configuration is 0.0065 (+0.002/-0.003) inches
   - Patterns B & E each consist of 41 conductors, for surface insulation resistance testing. Their end product configuration is 0.0125 (+0.002/-0.003) inches
   - Patterns C & F each consist of 21 conductors, for surface insulation resistance testing. Their end product configuration is 0.025 (+0.002/-0.003) inches
5. Feature patterns G&J are for interlaminate insulation resistance testing. See Table I for feature and hole size and location.
6. Feature H contains a 0.010 (+0.001/-0.002) inch conductor between 0.060 (+0.002/-0.003) inch lands. See Table I for location information. (There are no holes in this pattern).
7. Feature pattern K is for non-plated through hole bond strength testing. See Table I for feature and hole size location.
8. Feature pattern L is for plated through hole bond strength testing. See Table I for feature and hole size location.
9. Feature M is for peel strength testing.
10. Feature R is for plated-through hole conductivity testing. See Table I for feature and hole size and location.
11. When testing the multipurpose board with solder mask, the requirements of IPC-SM-840 shall apply. The following features are for solder mask testing:
    - Feature N is for solder mask adhesion testing
    - Feature P is for open dielectric area testing of solder mask material
    - Feature Q is for solder mask over metal surface testing
12. Unless otherwise specified, tolerances shown in figure 1 on three place decimals are ± 0.010 inches and on two place decimals are ± 0.030 inches.
13. Figure I identifies the circuit configurations to be used for certifying a a single sided board; Figure I and II define the circuit configurations to be used for a double sided board. (When a single sided board is being produced, the end product dimensions for drilled holes shall be equal to the dimensions for plated-through holes, shown in Table I.
14. Artwork for the IPC-B-25 Multipurpose Test Board may be purchased from the IPC, 1717 Howard Street, Evanston, Illinois 60202, and is identified as IPC-A-25.

REV. A PROPOSAL

IPC-B-25, MASTER DRAWING
MULTIPURPOSE TEST BOARD
(SINGLE & DOUBLE SIDED PRINTED WIRING)

SHEET 1 OF 2

FIGURE 1
PATTERN FOR
(SINGLE SIDED/DOUBLE SIDED)

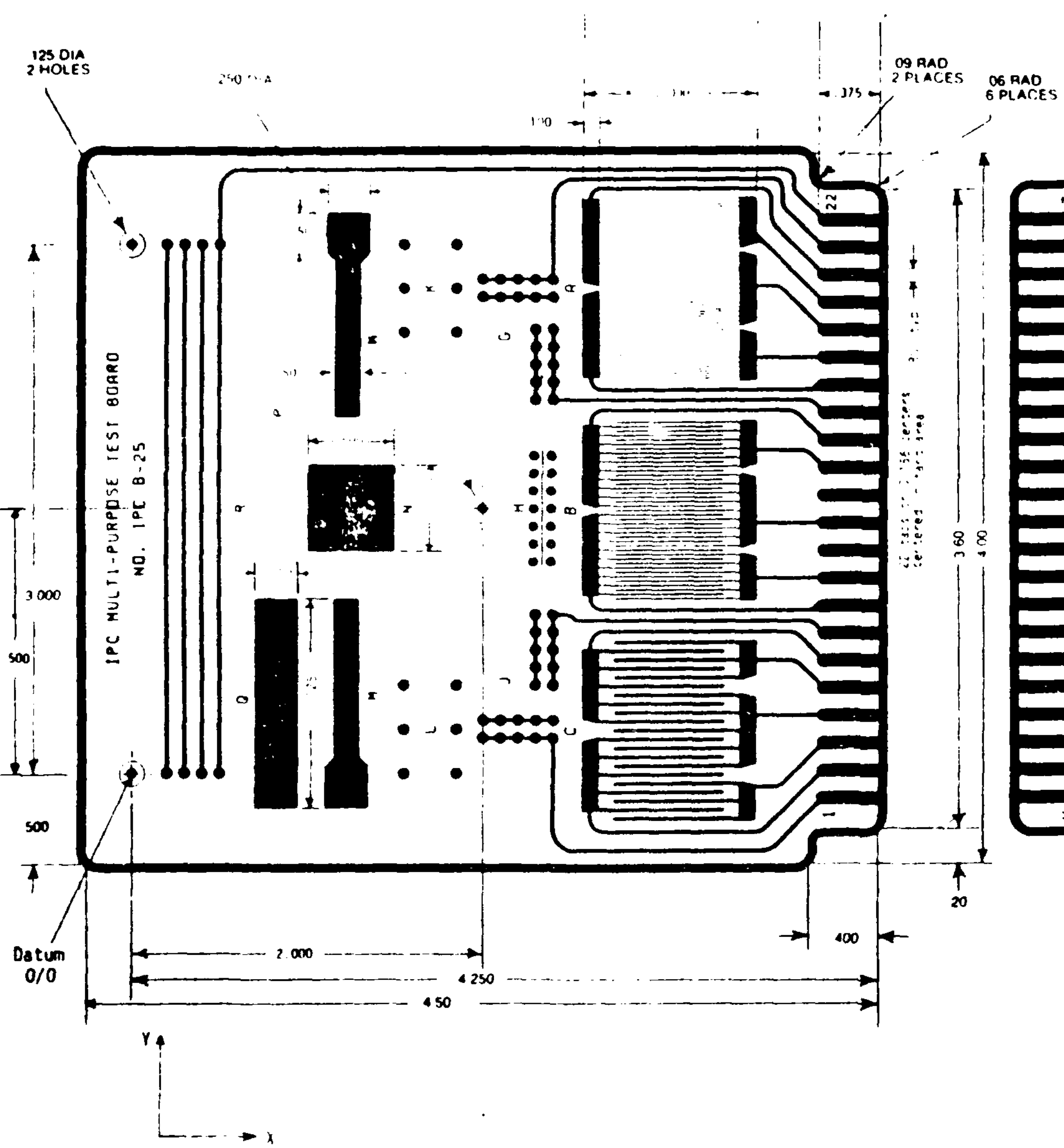
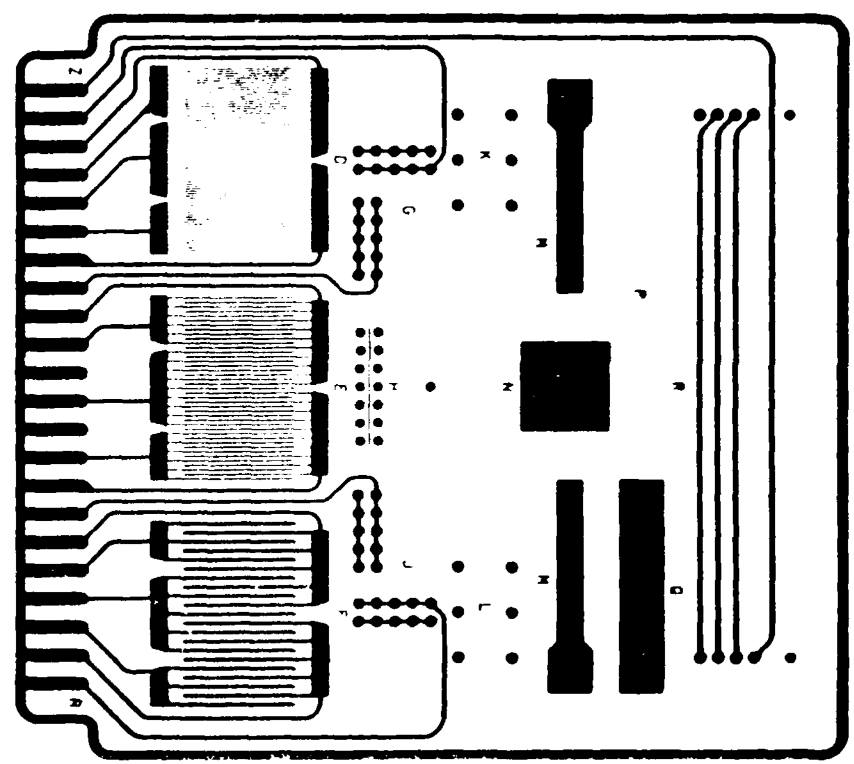


FIGURE 2
PATTERN FOR
(DOUBLE SIDED)



IPC-B-25, MASTER DRAWING

MULTIPURPOSE TEST BOARD

(SINGLE & DOUBLE SIDED PRINTED WIRING)

SHEET 2 OF 2

TABLE I
FEATURE LOCATION CHART

FEATURE	LOCATION X	LOCATION Y
See Note 4&6	PATTERN G	
A1	1.000	3.000
A2	1.125	3.000
A3	1.250	3.000
A4	1.375	3.000
B1	1.000	2.625
B2	1.125	2.625
B3	1.250	2.625
B4	1.375	2.625
B5	1.500	2.625
B6	1.625	2.625
B7	1.750	2.625
B8	1.875	2.625
B9	2.000	2.625
B10	2.125	2.625
B11	2.250	2.625
B12	2.375	2.625
B13	2.500	2.625
C1	1.000	2.250
C7	1.750	2.250
C13	2.500	2.250
D1	1.000	1.875
D13	2.500	1.875
E1	1.000	1.500
E13	2.500	1.500
F1	1.000	1.125
F2	1.125	1.125
F3	1.250	1.125
F4	1.375	1.125
F5	1.500	1.125
F6	1.625	1.125
F7	1.750	1.125
F8	1.875	1.125
F9	2.000	1.125
F10	2.125	1.125
F11	2.250	1.125
F12	2.375	1.125
F13	2.500	1.125
G10	2.125	0.750
G11	2.250	0.750
G12	2.375	0.750
G13	2.500	0.750
See Notes 4 & 6	PATTERN F	
1	5.500	0.750
2	5.500	1.000
3	5.500	1.250
4	5.500	1.500
5	5.500	1.750
6	6.000	0.750
7	6.000	1.000
8	6.000	1.250
9	6.000	1.500
10	6.000	1.750

FEATURE	LOCATION X	LOCATION Y
See Notes 4 & 6	PATTERN A	
1	5.600	2.400
2	5.400	2.400
3	5.400	2.750
4	5.400	3.100
5	5.600	3.100
6	5.900	3.100
7	6.100	3.100
8	6.100	2.750
9	6.100	2.400
10	5.900	2.400
See Notes 4 & 6	PATTERN H	
1	1.160	6.400
1'	1.160	5.000
2	1.825	6.300
2'	1.825	5.800
3	1.675	6.300
3'	1.675	5.800
4	2.850	3.700
4'	2.850	4.200
5	1.675	3.700
5'	1.675	4.200
6	1.825	3.700
6'	1.825	4.200
7	0.650	6.300
7'	0.650	5.800
8	2.850	6.300
8'	2.850	5.800
9	0.650	3.700
9'	0.650	4.200
10	2.340	3.600
10'	2.340	5.000
See Notes 4 & 6	PATTERN B	
1	3.500	5.625
2	3.625	5.625
3	3.750	5.625
4	3.875	5.625
5	4.000	5.625
6	3.625	5.875
7	3.750	5.875
8	3.875	5.875
9	4.000	5.875
10	3.500	6.125
11	3.625	6.125
12	3.750	6.125
13	3.875	6.125
14	4.000	6.125

NOTES:

1. Material thickness and copper clading to be as specified in detail A. Material to be per MIL-P-13949 - type (as required to be certified for a given product... see paragraph 4.5.3 of MIL-P-55110).

2. Plating in holes to be o.001 inch minimum copper, overplated with tin/lead (followed by reflow) or solder coated per paragraph 3.4.3 of MIL-P-55110.

3. Minimum annular ring requirement is 0.005 inches. (Tolerances on hole location shall be to achieve minimum annular ring. Pattern B&F shall be inspected and must be accurately located to within 0.003 inches RTP. See Table I for feature locations.

4. Interconnection plated-thru-hole diameter to be 0.035/0.045 inches unles otherwise specified.

5. All lines and spacing 0.020 ± 0.003 on all layers unless otherwise specified.

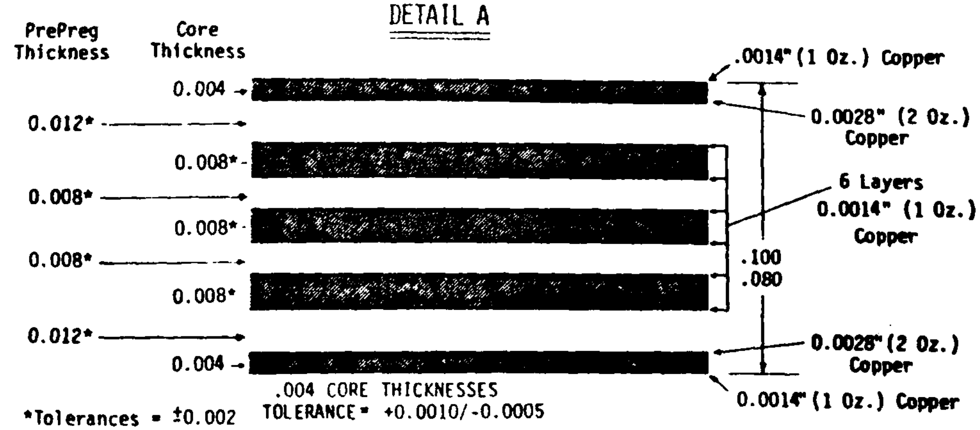
6. All lands are 0.070 ± 0.005 inches (Square or round).

7. Etched clearance holes in solid planes to be 0.100 (+0.010/-0.000) inches, and must match square or round configuration of lands.

8. Unless otherwise specified, tolerances shown in Figure 1 on 3-place decimals are ±0.010 inches and ± 0.030 in 2-place decimals.

9. Artwork for the IPC-B-27 Multilayer Test Board may be purchased from the IPC, 1717 Howard Street, Evanston, Illinois 60202, and is identified as IPC-A-27.

DETAIL A



*Tolerances = ±0.002

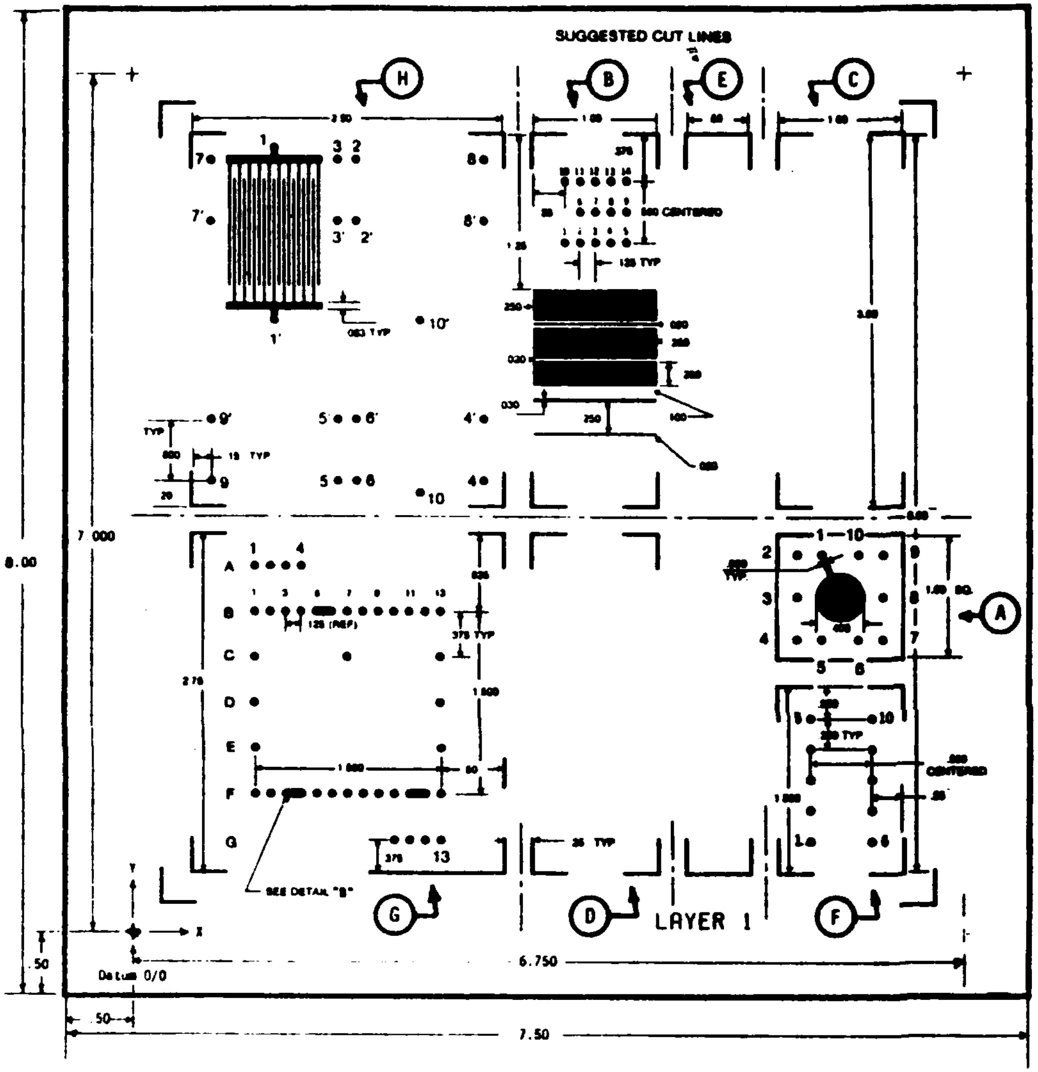
PROPOSAL

IPC-B-27, MASTER DRAWING SHEET 1 OF 4

MULTILAYER (IPC-ML-950) TEST BOARD

(TEN LAYER MULTILAYER PRINTED WIRING)

Figure 1. Layer 1 (Dimensioning and Legend are for reference only).



- PATTERN DEFINITION
(Not a Part of the Pattern)

Figure 2. Layer 2

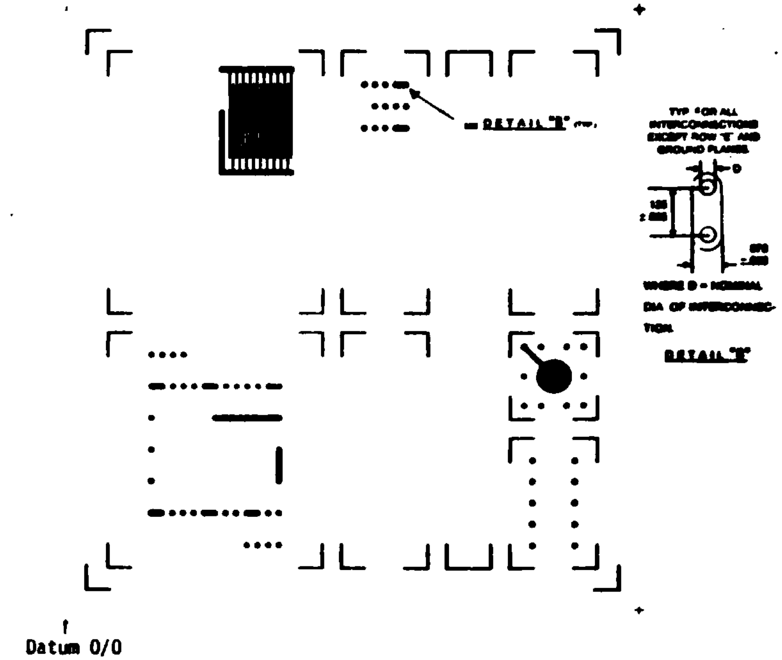
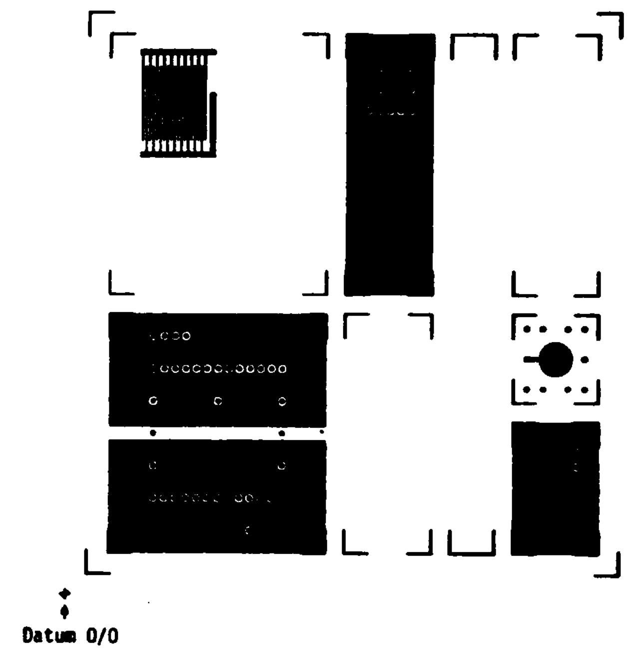


Figure 3. Layer 3



IPC-B-27, MASTER DRAWING SHEET 2 OF 4
MULTILAYER (IPC-ML-950) TEST BOARD
(TEN LAYER MULTILAYER PRINTED WIRING)

Figure 4. Layer 4

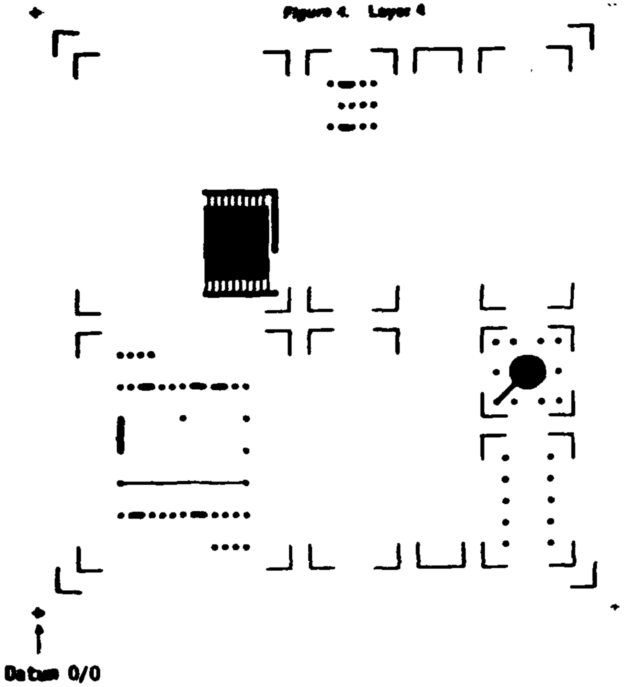


Figure 5. Layer 5

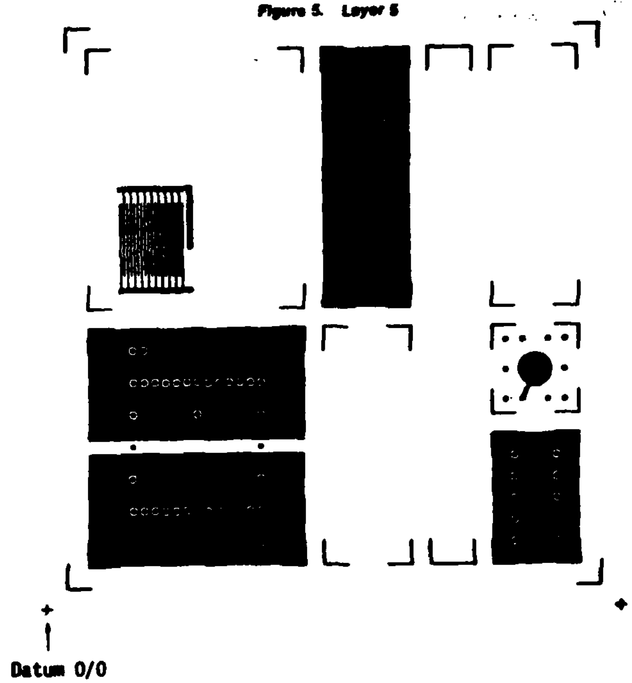


Figure 6. Layer 6

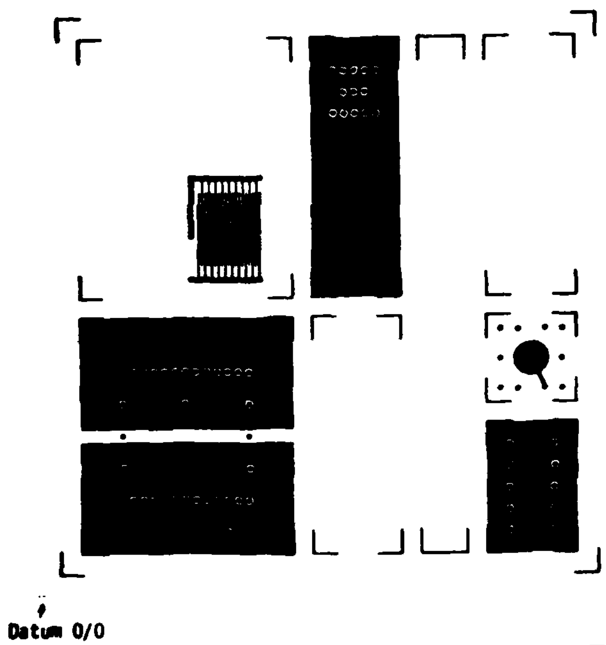
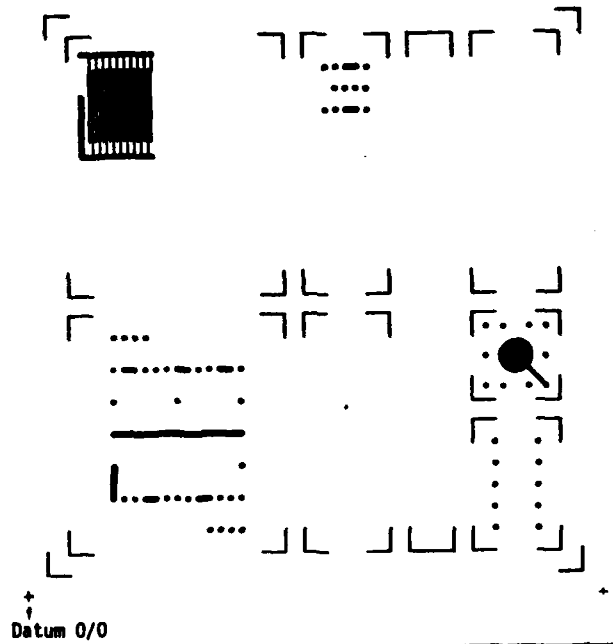


Figure 7. Layer 7



IPC-B-27, MASTER DRAWING SHEET 3 OF 4
MULTILAYER (IPC-ML-950) TEST BOARD
(TEN LAYER MULTILAYER PRINTED WIRING)

Figure 8. Layer 8

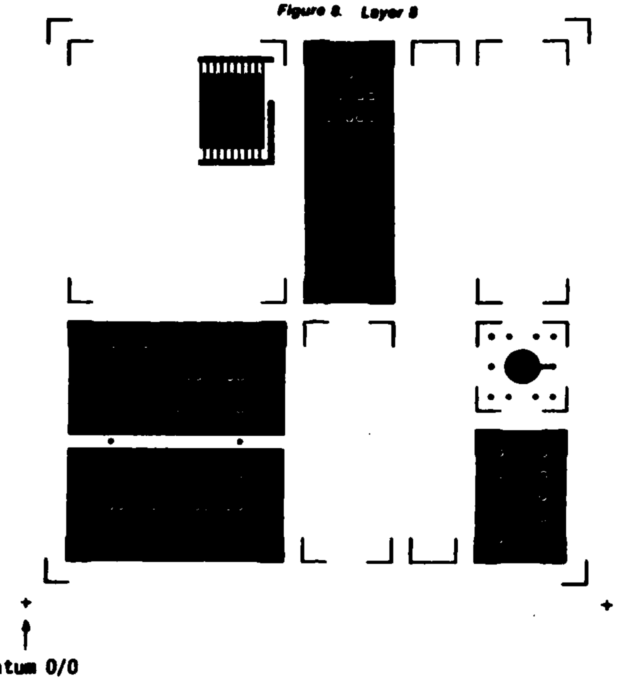


Figure 9. Layer 9

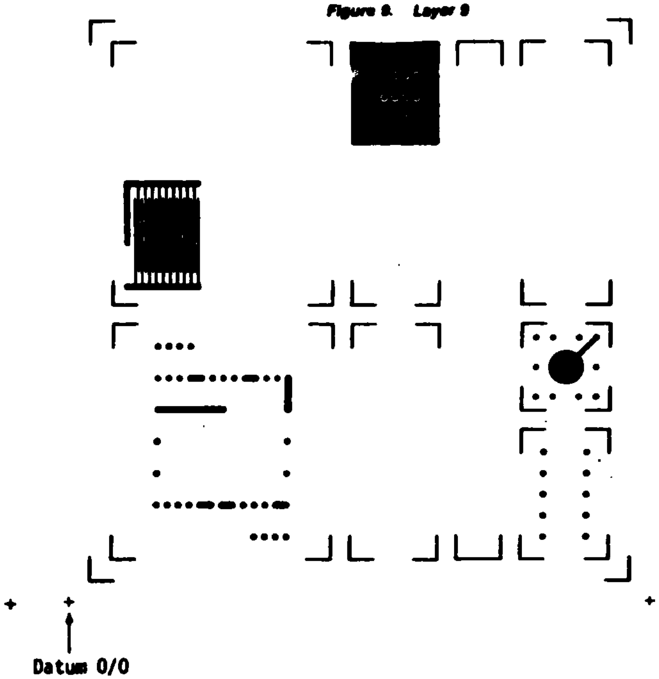


Figure 10. Layer 10

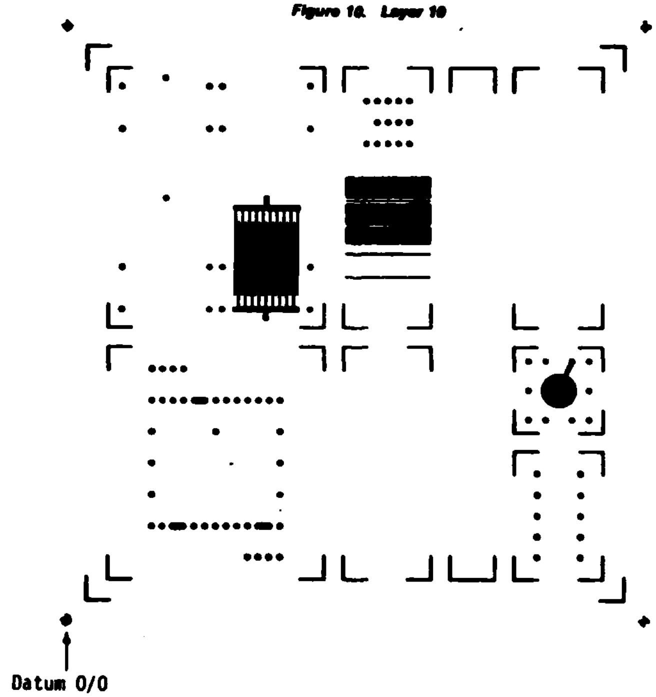
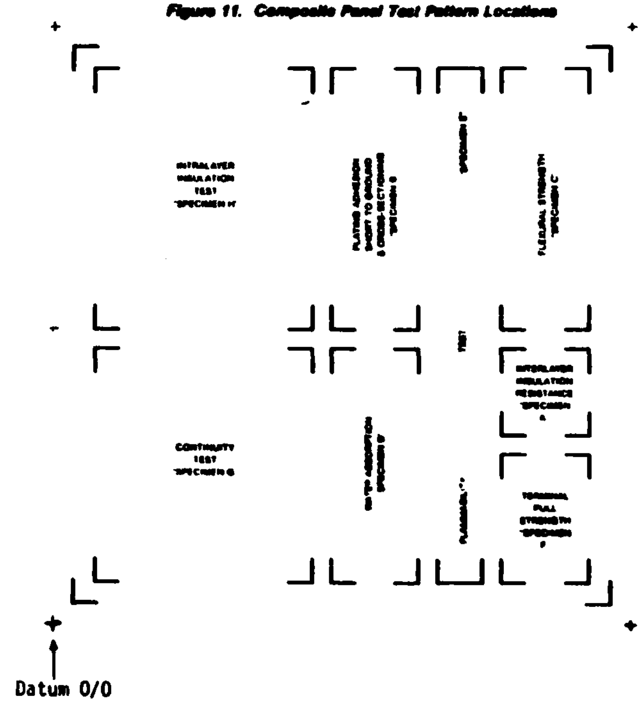


Figure 11. Composite Panel Test Pattern Locations



IPC-B-27, MASTER DRAWING SHEET 4 OF 4
MULTILAYER (IPC-ML-950) TEST BOARD
(TEN LAYER MULTILAYER PRINTED WIRING)

GOVERNMENT PANEL

ON

TECHNICAL DOCUMENTATION

Chairman:	DONALD R. MITCHELL Deputy Director Defense Material Specification and Standards Office
Panel Members:	ROBERT BOOHER Headquarters, U.S. Air Force Logistics Command
	G.W. MICHAELIS U.S. Navy Construction Battalion Center
	T. HARRISON U.S. Army Missile Comand Redstone Arsenal
	DONALD SWANSON Defense Electronic Supply Command

Government panel discussions are not normally recorded in the proceedings. Mr. Swanson's presentation, however, is contained on the following pages.

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DEPARTMENT OF DEFENSE PARTS CONTROL PROGRAM

DONALD SWANSON
Defense Electronic Supply Center

NOTE: This paper was transcribed from a recording of the session.

It's a pleasure for me to be here today and to have an opportunity to tell you about the DoD Parts Control Program. I will tell you something about what we do and what the Military Parts Control Advisory Group (MIPCAG) is. The acronym MPCAG (pronounced "mip-cag") will be referred to quite a few times during this short briefing. I'll give you an overview, some background on where the program came from, how it works, what we do, some of the benefits, and how it has grown.

There are three basic objectives of a Parts Control Program (Figure 1): (1) minimize the variety of parts that are being designed into new equipment and thus also minimize the variety of nonstandard parts that are entering the DoD Logistic inventory, (2) enhance and maintain the reliability of the Systems by maximizing the use of standard parts while minimizing the different varieties of parts, and (3) keep the military specifications and standards current--we simply must have current specifications if we are going to recommend standard parts.

Every study and report that we reviewed, dating back several years, has a common thread; that is, if you are going to be successful in standardization, you must do it while the equipment is being designed (Figure 2). If you wait until the equipment is in the Government inventory to try to standardize the parts, it's simply too late.

In 1969, a DoD Task Group tried to determine if a centralized group of engineers and technicians could be effective in trying to promote standardization during design. They determined that perhaps a study project should be conducted to see if standardization would work and if a group of parts experts could improve the standardization during the design phase working with military procuring activities and their contractors. They initiateda study project and named the Defense Electronics Supplies Centers Engineering Directorate (DESC-E) to conduct the study. This wasn't really an accidental selection because we had a couple of things going for us at the time. We had fully one fourth of all the new stock numbers that were being assigned to the federal supply classes. Thus we had a proliferation problem in electronic parts. Many nonstandard parts were being entered into the inventory each

year. We also had a group of parts experts that had been preparing military specifications and standards on resistors, capacitors, and other various electronic components for many years as agent for the various military departments. We had those two things going for us and we determined how to conduct a feasibility study and embarked upon it, supporting Air Force contracts primarily, plus one or two Army, and one Navy contract.

Even before the study was completed and a final report prepared, it was determined that it was a very cost effective program. In 1972, DESC-E became the first Military Parts Control Advisory Group designated to support military contracts. They were asked by the procuring activity to help in the selection of standard parts during the design phase. The program continued to grow and, in 1975, the JL Report indicated that this was a good program, should be DoD-wide, and further that there should be a DoD policy generated for the program. So the DoD Task Group was reactivated under Mr. Mitchell's chairmanship. They developed DoD policy documents for the Parts Control Program in the form of DoD Instruction 4120.19 in December 1976 (Figure 3). This was followed by implementing instructions and regulations by the Military Department and Defense Logistics Agency (DLA).

In 1977, MIL-STD-965 which is the contract implementing document along with the data items required for implementing the program were all completed; we had a full-fledged DoD Parts Control Program.

Now the responsibility for implementing the program lies both with the Military and DLA (Figure 4). The Military must first contractually implement the program by applying the data item--a voluntary effort simply is not successful. Of course, the Military also retains the authority and responsibility for final approval of whatever is used in their equipment; they have the authority and the right to say what parts are going to be used.

What the MPCAG does is to provide a technical expert sitting at the design activity's right hand to make recommendations. DLA, for its part, agreed to take the responsibility to establish additional MPCAG's at other centers where they had parts experts working in other areas--mechanical parts, electrical parts, etc. These MPCAGs would provide part selection expertise to the Military Departments, create an automated data processing system that would provide for rapid storage and retrieval of nonstandard parts data. They not only determine the standardization needs, but do something about it. In other words, they would change the specifications and standards to keep them in a current condition, adding those parts that needed to be added.

Figure 5 lists the various MIPCAG areas of responsibility. In 1972, DLA created the DESC-E MPCAG covering the items listed. In 1975, they created another MPCAG, a mechanical part MPCAG at the Defense Industrial Supply Center in Philadelphia, covering bearings, fasteners, and mechanical parts of this type. Then in 1978,

two additional MPCAGs at Defense General Supply at Richmond and another Defense and Construction Supply in Columbus, Ohio, were created to cover the entire gamut of electrical, electronic and mechanical parts the military feels need to be controlled during new design efforts. In conducting this program, we work with virtually everybody that is interested in using parts, manufacturing parts, etc. The various military departments and the major commands within those departments have engineers that interface with the major industry associations, as well as the various OEMs and contractors with whom we interface on a daily basis in trying to help them with the selection of standard parts for new designs.

Figure 6 depicts the basic interface that occurs and how the ongoing program works. It shows MPCAG supporting the military procuring activity and the contractor. Figure 7 shows a lot of communication with the contractor, not only in writing but by phone. Our engineers talk to the designer and contractor about part problems, and if he is requesting the use of a nonstandard part, he can do so by phone. We will document that request, make a recommendation on it, and forward it to the procuring activity. In this way, the procuring activity knows what has been talked about and what we recommend. Through telephone requests,the cost of paperwork is reduced; therefore the overall cost of the contract should be reduced.

We not only review parts over the phone, but list the proposed parts he intends to use in design. If a nonstandard part is approved and he covers it with a drawing, we review the drawing and offer recommendations as to its adequacy for follow-on procurement by the Military when it becomes Government property. In addition, we provide expedited military specification service for those items that need to be covered by military specification. We have put out military specifications in as little time as two weeks. QPL information is provided to the procuring activity and the contractor during the design phase of a piece of equipment or gear. So our main purpose (Figure 8) really is to make recommendations quickly (we emphasize the term "recommendations") to the equipment designers acting as the technical experts for the procuring activity.

Now you say, "So what? Why are you so worried about nonstandard parts getting into the system?" Well, there are a lot of things that happen when nonstandard parts enter the system and they are all pretty costly (Figure 9). In the acquisition phase, each nonstandard part that's approved usually requires some documentation in the form of a specification or source control drawing or other document. These documents cost the Government lots of money. We've had data that indicated they range from $500 up to $8000 in cost. We're talking about the cost of verification testing of a nonstandard part that's been approved by the OEM to determine that it meets the requirements of the system contract. These tests can cost as much as $25,000. We've seen invoices reflecting these costs for some of the more complex microcircuits that have been thoroughly tested.

Those costs are in the acquisition phase. On the logistics side, of course, every new stock number that's assigned costs administrative money. To support what we are using right now at DESC is $270 administrative cost for every Federal Stock Number (nonstandard number) that is developed. If you go further and talk about maintaining the nonstandard number over a 10-year life of the equipment, you're looking at another $1600. On top of that, if you add the fact that the nonstandard part will tend to fail more often than the standard part, and apply some very conservative figures of say $300 for each maintainance action, over a 10-year life you're talking about at least $3000 for each nonstandard part. These are the types of costs that are incurred by nonstandard parts and the costs we are trying to avoid. Significant savings can be realized. That's what our benefit to the equipment, to the system, and to the logistic system is based on.

Let me take a moment to give you an example of what I'm talking about (Figure 10). We were seeing a lot of operational amplifier microcircuits and we tried to develop a trend to see what types were actually being used. We discovered that about four basic part types and about twenty different part numbers covered most of the requirements. We had 50 and 60 nonstandard parts come in requesting approval. We didn't have a standard to recommend in their place. So we took the four part types and twenty part numbers and put them in a slash sheet to MIL-M-38510 (/101) and applied them on all new nonstandard parts where these parts would do the job. We recommended /101 parts and, in fact, they was used.

If you apply the mathematics to the costs of the testing that was avoided, the drawings avoided, and the logistic savings; the first year alone we were looking at $500,000 worth of cost avoidance. That's not out-of-pocket savings, it's what we would have spent if we had not been involved in the program. We looked at that recently to see if we really had accomplished what we thought we accomplished with that one basic standardization action. We reviewed material back to 1973 (Figure 11). We had recommended that slash sheet (/101) items 491 times on 125 contracts. If you apply the conservative mathemathics to that figure, you're looking at 6 million dollars worth of savings. Of course, it's not free--we had to create and maintain the specification, but for $61,000 cost for that we have a 103-to-1 benefit-to-cost ratio. For every dollar we spent we avoided $103 in expenditure.

Figure 12 illustrates the breakdown of the contracts, by percentage, that we work on today. Still, almost half of them are Air Force contracts. The Air Force saw the need for a centralized activity as far back as 1967 and we have been working with them for many years. The Army and Navy have been increasing the number of contracts that we work on for some time now and they are improving as far as quantity is concerned but their percentage, of course, stays pretty much the same.

Just a quick word about MIL-STD-965 that I mentioned earlier (Figure 13): it replaces some documentation that you may be aware of including MIL-STD-749, the old submittal of non-standard parts document. It's a DoD Program and MIL-STD-965 was written by the DoD Task Group, as I mentioned. Figure 14 shows how the program has grown. Contracts supported by us in 1973, when the DECS MPCAG was very young, totaled 57 contracts. It's grown every year to the 396 supported in 1978. To date, we have worked on over 450 contracts and this includes projects like F-16, F-18, small black boxes, small pieces of equipment, modification contracts, almost all the major weapon systems (Figure 15). We support the military procuring activity and their contractor or contractors on the program.

The life cycle cost avoidance runs into the millions of dollars. Obviously, our costs (fourth column in Figure 14) have gone up because we have many more contracts to work on and we've had to acquire additional resources. But we are still looking at an 83-tol benefit-to-cost ratio. For every dollar we spend on the program, we avoid an $83 expenditure. That is basically the Parts Control Program.

Thank you very much.

PARTS CONTROL SYSTEM OBJECTIVES

- MINIMIZE VARIETY OF PARTS
- ENHANCE SYSTEM RELIABILITY AND MAINTAINABILITY
- KEEP SPECIFICATIONS AND STANDARDS CURRENT

Figure 1

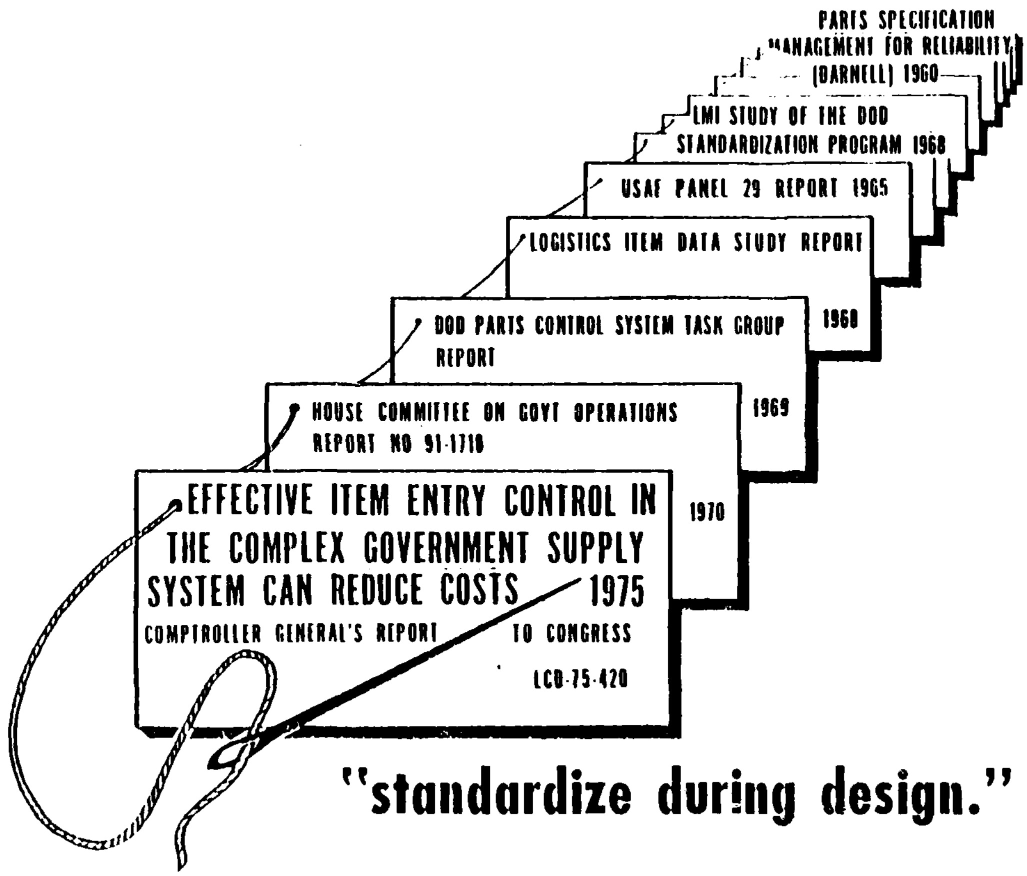
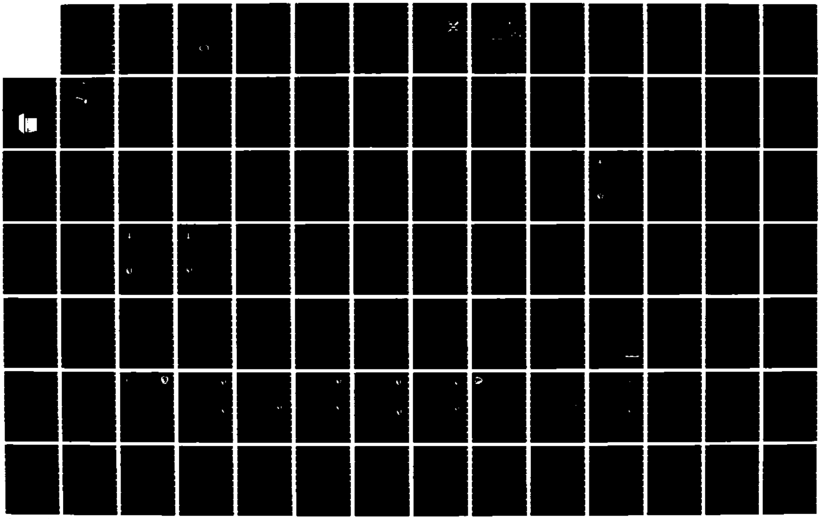
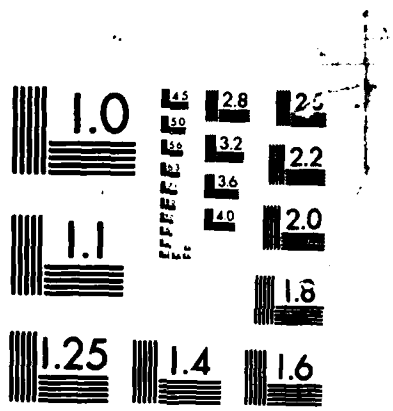


Figure 2

AD-A169 182 PROCEEDINGS OF THE ANNUAL MEETING OF THE TECHNICAL DOCUMENTATION DIVISION..(U) AMERICAN DEFENSE PREPAREDNESS ASSOCIATION ARLINGTON VA MAY 79 2/3

UNCLASSIFIED F/G 5/1 NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.8
3.2
3.6
4.0

DOD PARTS CONTROL SYSTEM POLICY

● DOD INSTRUCTION	4120.19	DECEMBER 1976

MILITARY SERVICE REGULATIONS

● AIR FORCE	AFR 800-24	DECEMBER 1977
● ARMY	AR 700-60	OCTOBER 1977
● NAVY	NAVMATINST 4120.106	MARCH 1977
● DLA	DLAR 4120.12	JUNE 1977

CONTRACT IMPLEMENTATION

● MIL-STD-965	PARTS CONTROL PROGRAM	15 APRIL 1977

Figure 3

RESPONSIBILITIES

MILITARY DEPARTMENTS

- ENSURE IMPLEMENTATION IN CONTRACTS
- RETAIN AUTHORITY/RESPONSIBILITY FOR PARTS SELECTION

DLA

- ESTABLISH MILITARY PARTS CONTROL ADVISORY GROUPS (MPCAGs)
  - MAINTAIN BROAD DATA BASE FOR PARTS
  - PROVIDE PARTS SELECTION RECOMMENDATIONS TO DESIGNERS
  - USE AUTOMATION TO PROVIDE RAPID FLOW, RETENTION, RETRIEVAL OF INFORMATION
  - DETERMINE STANDARDIZATION NEEDS

Figure 4

PRODUCTS FOR MPCAG SUPPORT

ELECTRICAL/ELECTRONIC PARTS		MECHANICAL PARTS	
DESC DAYTON	DGSC RICHMOND	DISC PHILADELPHIA	DCSC COLUMBUS
RESISTORS	TERMINALS, LUGS	BEARINGS	GEARS
CAPACITORS	INSULATORS	FASTENERS	BOLTING
FILTERS	ELEC CABLE ASSY'S	SEALS	PIPE & TUBES
FUSES	LIGHTING DEVICES	MISC HARDWARE	TUBE FITTINGS
CIRCUIT BREAKERS	LAMPS	KNOBS	VALVES
SWITCHES	TIME TOTALIZING METERS	SPRINGS	
CONNECTORS (ELEC)		RINGS, SHIMS	
RELAYS		CABLE FITTINGS (MECH)	
TRANSFORMERS			
CRYSTALS			
TUBES (ELTR)			
TRANSISTORS/DIODES			
MICROCIRCUITS			
AUDIO			
WAVEGUIDES			
SYNCHROS			
MISC ELEC			
WIRE & CABLES			
METERS (PANEL)			

Figure 5

who we work with

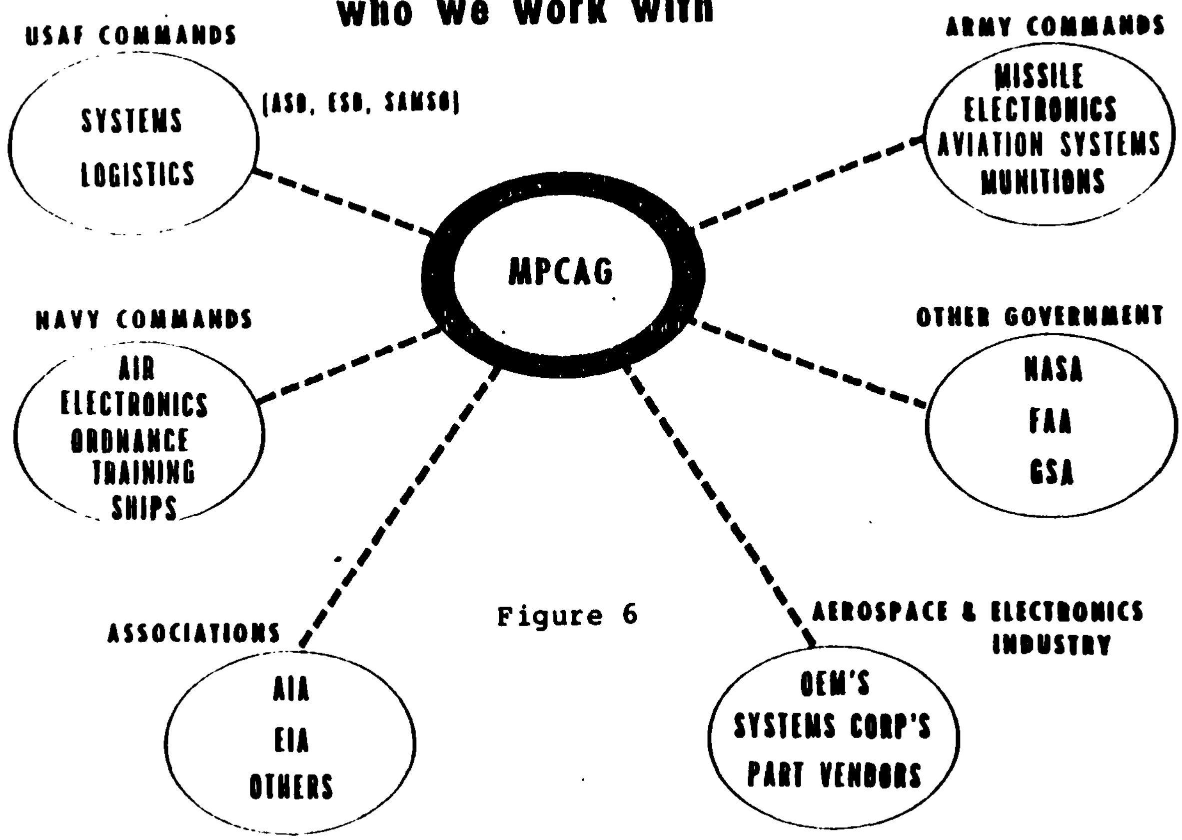
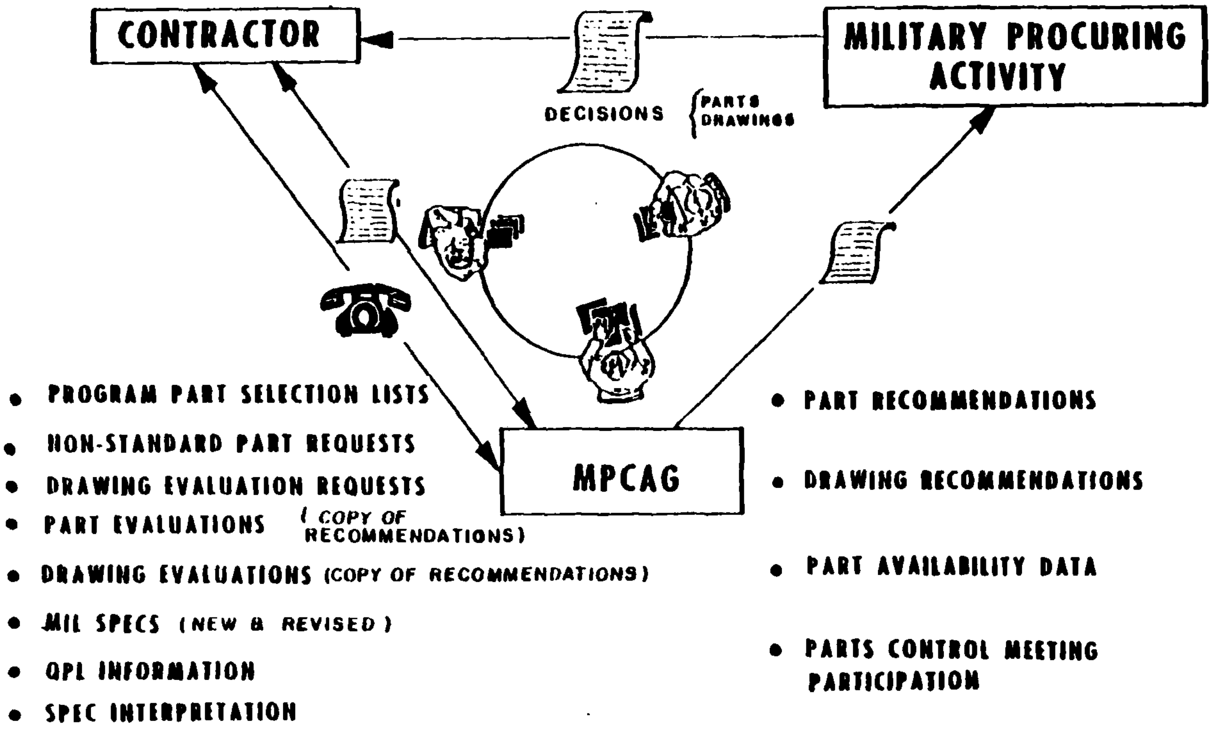


Figure 6

MPCAG continuing support



OPERATION OF MILITARY PARTS CONTROL ADVISORY GROUP (MPCAG) IN DESIGN SELECTION.

Figure 7

our main purpose

PROVIDE ENGINEERING RECOMMENDATIONS

TO EQUIPMENT DESIGNERS

IN SELECTION AND USE

OF STANDARD PARTS

Figure 8

★ LIFE CYCLE COST OF EACH NON-STANDARD PART

ACQUISITION

- ACQUISITION OF DATA PACKAGE (DRAWING $500 - $8,000)
- VERIFICATION TESTING OF SELECTED DEVICE (TESTING $5,000 - $25,000)

LOGISTICS

- ITEM ENTRY TO LOGISTICS ($207)
- MAINTENANCE OF NATIONAL STOCK NUMBER AND BIN SPACE ($1,650)
- RELIABILITY – MORE MAINTENANCE ACTIONS ($3,000)

Figure 9

benefits accrued from a decision to standardize during design

DESCRIPTION OF PART STANDARDIZED:

MICROCIRCUIT, LINEAR OPERATIONAL AMPLIFIER

MILITARY SPECIFICATION:

MIL-M-38510/101

PART TYPES: 4 PART NUMBERS: 20

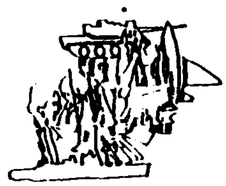
Figure 10

★ EXAMPLE OF STANDARDIZATION BENEFIT

LESSONS LEARNED

PART TYPE: MIL-M-38510/101 MICROCIRCUIT, LINEAR OP AMP

- NONSTANDARD TYPES REPLACED SINCE 1973 – 491 REPLACEMENTS
- USED ON 125 CONTRACTS (ARMY - 18) (NAVY - 29) (AF - 78)



BENEFIT	COST
DRAWINGS AVOIDED	SPEC PREPARATION
TESTS AVOIDED	SPEC MAINTENANCE
NSN'S PREVENTED	QPL MAINTENANCE
NSN'S REPLACED	NEW NSN'S
MAINTENANCE ACTIONS AVOIDED	PART EVALUATIONS
	ITEM REDUCTION
TOTAL: $6,349,612	TOTAL: $61,641

BENEFIT TO COST 103 TO 1

Figure 11

CURRENT CONTRACT DISTRIBUTION

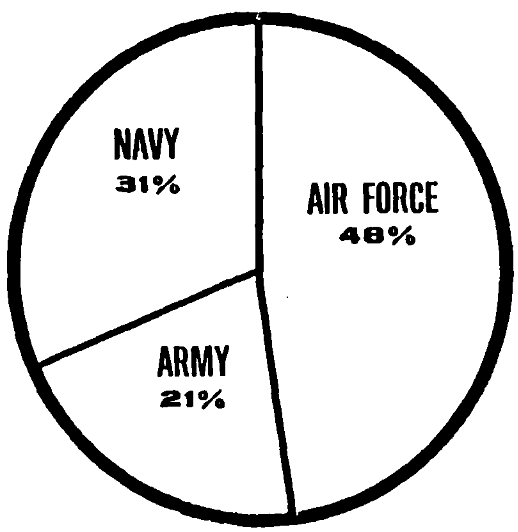


Figure 12

new DoD parts control system

DoD INSTRUCTION 4120.19 "DEPARTMENT OF DEFENSE PARTS CONTROL SYSTEM" Dated: 16 DECEMBER 1976

IMPLEMENTING DOCUMENT

MIL-STD-965
PARTS CONTROL PROGRAM

Dated: 15 APRIL 1977

REPLACES

SUPERSEDED DOCUMENTS

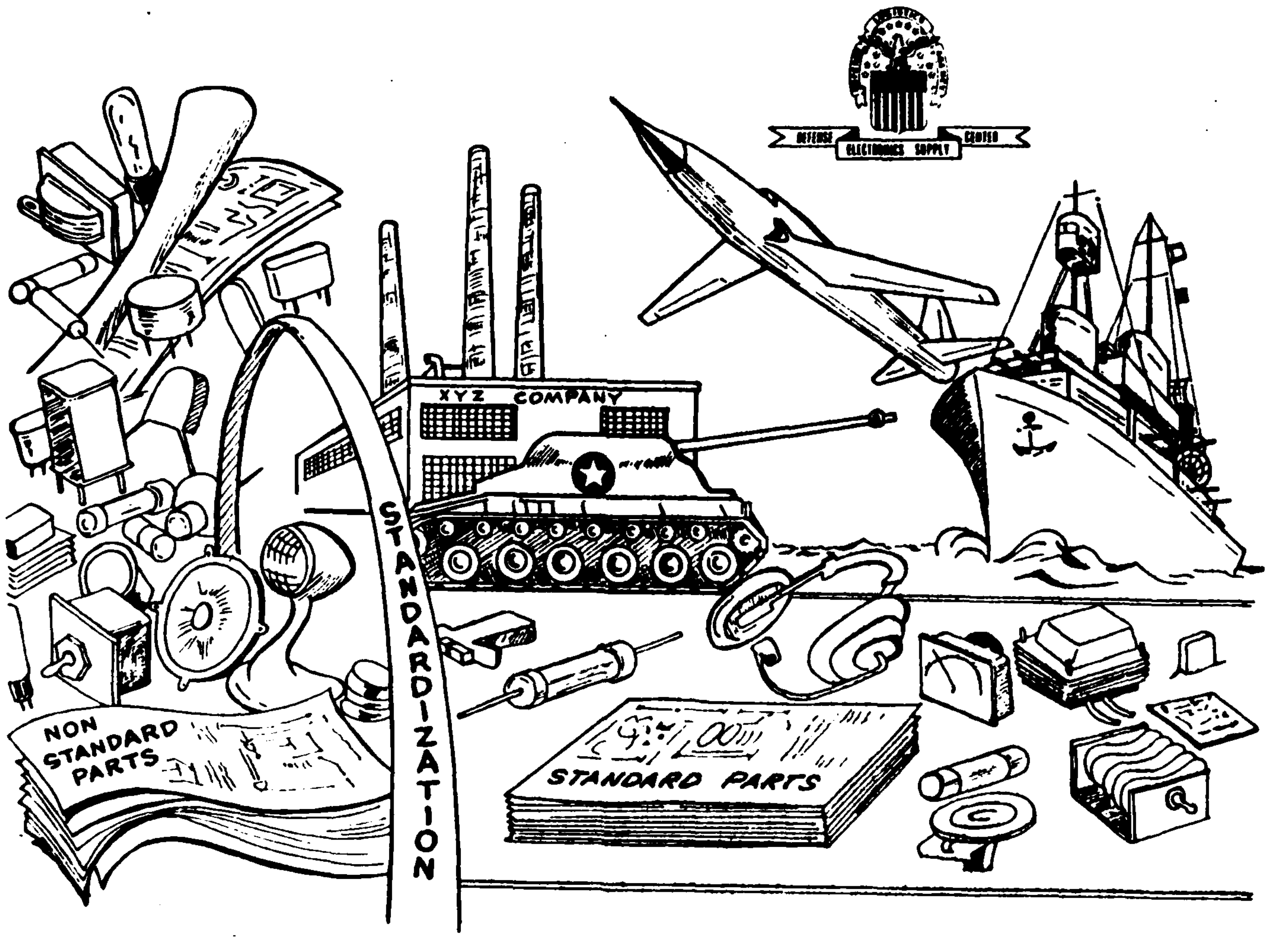
MIL-STD-749
MIL-STD-891(USAF)
MIL-STD-1631(NAVY)
MIL-STD-1652(NAVY)

Figure 13

GROWTH OF PARTS CONTROL PROGRAM

FISCAL YEAR	TOTAL CONTRACTS SUPPORTED	LIFE CYCLE COST AVOIDANCE $MILLIONS	MPCAG COST $ MILLIONS	BENEFIT/COST
1973	57	$ 40	$ .67	58:1
1974	97	53	.77	68:1
1975	142	84	.83	101:1
1976	184	114	.84	136:1
197T & 1977	290	127	1.35	94:1
1978	396	134	1.60	83:1

Figure 14



DEFENSE ELECTRONICS SUPPLY CENTER
XYZ COMPANY
STANDARDIZATION
NON STANDARD PARTS
STANDARD PARTS

Figure 15

SESSION 3

Chairman: CHARLE W. GEDNEY
Research Analysis and
Management Corporation

Secretary: DONALD C. DEROSIA
General Electric Company

THE USER-ORIENTED TECHNICAL MANUALS FOR AEGIS

J. Fedorko
Naval Sea Systems Command
Washington, D.C.

R.D. Kemp
RCA Government and Commercial Systems
Missile and Surface Radar
Moorestown, New Jersey

ABSTRACT

A job information delivery system was designed to provide AEGIS with readiness assessment and fault analysis data. This consists of the highly automated Operational Readiness Test System (ORTS), supplemented by job-relevant work packages contained in an automatic retrieval microfiche file. This paper reviews the job information delivery system and describes how the concept of task-oriented data was expanded to include management, supervisory, and operational positions within the AEGIS Combat System.

THE USER-ORIENTED TECHNICAL MANUALS FOR AEGIS

J. Fedorko and R. D. Kemp

INTRODUCTION

The AEGIS Combat System in DDG 47 is a rapid-reaction, high-firepower surface missile system capable of dealing with the threats of the 1980's and beyond. The unprecedented quick reaction time and firepower of AEGIS stem from computer-managed operations coupled with a multi-function phased array radar capable of simultaneously performing all search, fire control quality tracking, and missile command midcourse guidance functions.

In addition to being the most advanced Navy defensive weapon system, AEGIS has introduced an unprecedented level of system availability. This combination of capability and availability is clearly a result of careful preplanning. A major objective of the AEGIS design was to produce a system that provided continuous combat readiness at an acceptable level of performance. To desensitize system availability from individual item malfunctions, a channelized load-sharing, redundancy design approach was established. In this approach, the individual building blocks are designed and interconnected so that multiple paths complement one another in providing full capability, yet are sufficiently independent that a malfunction in one path will not restrict operation in the remaining paths.

This approach to system design tends to de-emphasize the urgency for immediate maintenance, permitting deferral of many non-critical maintenance actions until the next scheduled maintenance period, or until cruise conditions permit. Nonetheless, continuous monitoring of system performance is required to identify critical events that threaten to bring the system down or degrade the system to an undesirable operating level. The Operational Readiness Test System MK 1 (ORTS) provides on-line monitoring of the equipment and programs, automatic computer reconfiguration to maintain the most efficient system, a centralized management of all AEGIS maintenance activity, fault detection, and, in many cases, fault isolation to the line replaceable unit (LRU).

OPERATION READINESS TEST SYSTEM

The ORTS is a data acquisition, data processing, and display system dedicated to continuously monitoring the AEGIS system for the detection and analysis of faults.

ORTS provides a comprehensive on-line assessment of system availability, readiness, and performance through a computer-controlled operation that is interleaved with the tactical program on a non-interference basis. The operator stationed at the ORTS console is provided with performance capability and fault analysis data consisting of fault location,

seriousness of fault (performance degradation), and recommended steps of reactions to take when correcting the fault. All operator input instructions are initiated by keyboard entry. After replacement of the indicated faulty line replaceable unit (LRU), the operator can manually initiate tests by entering a specified code via the keyboard to verify that the corrective maintenance eliminated the fault.

In essence, ORTS is a job information delivery system that automatically evaluates the entire system status, performs fault detection and fault isolation, and permits efficient scheduling of maintenance events. Detailed procedural information for corrective maintenance is not included in the ORTS message because of limitations on available computer memory and the high cost of changing formatted messages. Therefore, the maintenance procedure is replaced with a reference to documentation which is contained in a microfiche automatic retrieval storage and display unit to create a supplementary job information delivery system for AEGIS.

MICROFICHE FILE

The microfiche automatic retrieval storage and display unit is a shipboard qualified version of the commercially available unit manufactured by Image Systems Inc. of Culver City, California (Figure 1). One carrousel tray which holds 780 microfiche cards (over 76,000 frames) is contained within the unit (Figure 2); cartridges are available to extend the machine capability beyond this carrousel limitation. Automatic random access card search and selection allows insertion of the cards in any sequence. Any microfiche frame can be displayed within three seconds after insertion of a five-character code at the keyboard. A hard copy printout can be obtained from the dry process printer which has been incorporated as an integral part of the unit.

WORK PACKAGE CONCEPT

All AEGIS maintenance activity is planned and organized into specific step-by-step procedures for the technician to follow in response to a system fault symptom or a scheduled maintenance task. Test equipment and procedural guidance are readily and conveniently available to him, even for the faults most difficult to locate and fix. Figure 3 depicts the AEGIS maintenance sequence, utilizing a system-level work package that corrects a majority of the faults without use of external test equipment or more detailed information than that contained in the initial work package. All ORTS fault isolation messages contain a reference to a microfiche work package (see Figure 4). Equipped with the work package (see Figure 5), the technician can draw the LRU to be replaced from the designated cabinet, proceed to the equipment, and replace the faulty LRU. Retest to ensure that the replacement corrected the fault is accomplished by typing in a code at the ORTS keyboard. A reference to a more detailed equipment-level work package is included, to be followed whenever the replacement unit fails to correct the fault.

Equipment-level work packages are required when either the replacement LRU fails to correct the fault, ORTS does not fault-isolate to the LRU, or when performance of preventive maintenance indicates a fault. These detailed work packages start with the observed fault and then logically process through troubleshooting steps that have been determined by maintenance engineering. Instructions for use of portable test equipment, where required, are included in equipment-level work packages. These work packages provide the technician with detailed and specific job-related material until the fault is systematically corrected. Reference diagrams are included with equipment-level work packages. These diagrams are uniquely formatted for microfiche and are compatible with hard copy requirements. This particular format was developed to satisfy comments on microfiche supplied by users in the fleet.

TASK ORIENTED DATA

The maintenance work package concept produced job relevant data in only the corrective maintenance sections of the technical manuals. This was unacceptable to the Project Manager, PMS-400, since it did not eliminate the inherent problems of the existing multi-volume system manuals and their multiple users, such as:

- enormous table of contents
- desired material difficult to find
- material not satisfying different interests of all readers
- material written to incorrect comprehensibility/reading levels
- superfluous material

The project manager directed that an analysis be performed and other candidate areas for task oriented data be identified. As a result of the analysis, all management, maintenance, and operational personnel and their responsibilities were defined. Four organizational levels or tiers were established in both the maintenance and operational areas, and a new technical manual hierarchy was developed. The project manager accepted the recommendation that task-oriented material be prepared in accordance with the hierarchy, provided that the material remained compatible with training requirements and did not compromise any configuration management doctrine.

The technical manual hierarchy for the maintenance area was established to support the tasks at four levels: combat system test officer/maintenance supervisor, group supervisors, work center supervisors, and maintainers (see Figures 6 and 7). The manuals for the top three tiers of maintenance management address specific management tasks and contain technical material required for that level of supervision. The information to support the maintainer level is divided into information modules which agree with Naval Enlisted Classification (NEC) descriptions or with practical work assignments. Where applicable, the information is in work package format for automatic retrieval from the microfiche unit.

A similar hierarchy of combat system operational manuals was developed to support the Combat Information Center (CIC) operational tasks at four levels: tactical command, mission coordination, system supervision, and system operation/control (see Figure 8). Each person in CIC requires data to describe the generalities of operation in all warfare modes, console/equipment descriptions, specific principles of operation, and submode operating procedures. The specific principles of operation must define the duties of each person in CIC, varying from Task Force Commanders to equipment level console operators. The CIC multi-purpose consoles, under computer control, can accept various submode assignments. These qualifications dictate a modular approach for generation and packaging of the information to maintain the same flexibility that was designed into CIC. The resulting information modules or pamphlets may be gathered into a binder to provide each position or operator with the task-oriented data required (see Figure 9).

To eliminate redundancy of non-procedural descriptive data, it was recommended that a technical manual which contains all system level physical and functional description be generated for common use of all combat system personnel.

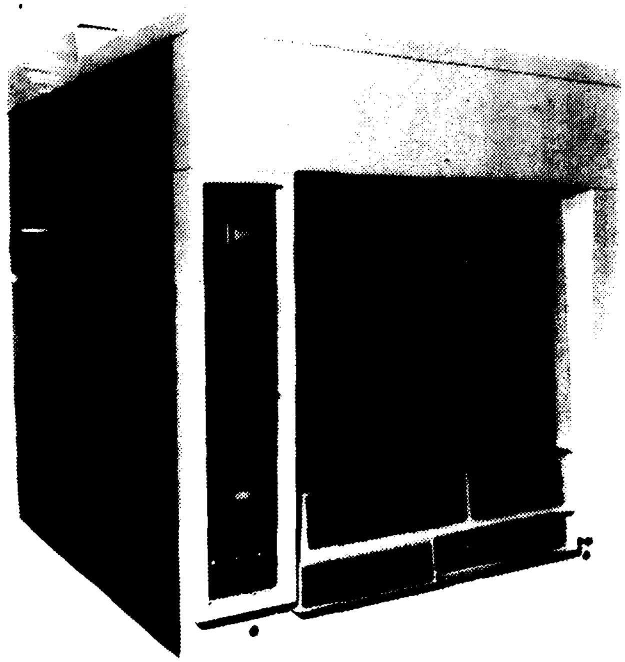


Figure 1. Microfiche Retrieval Storage and Display Unit

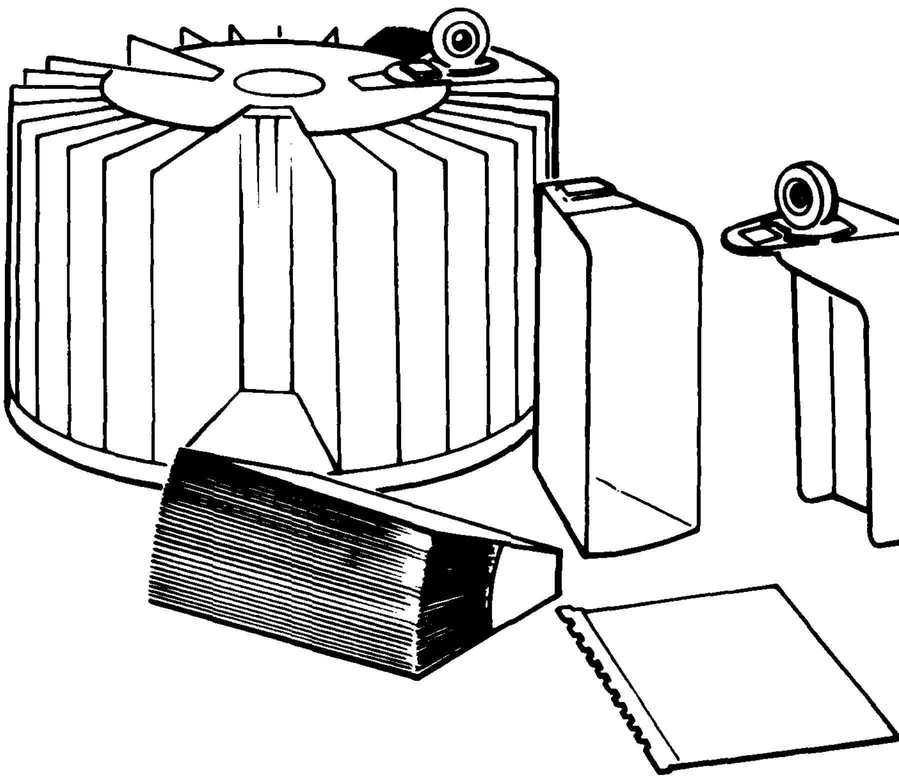


Figure 2. Cartridge Capability

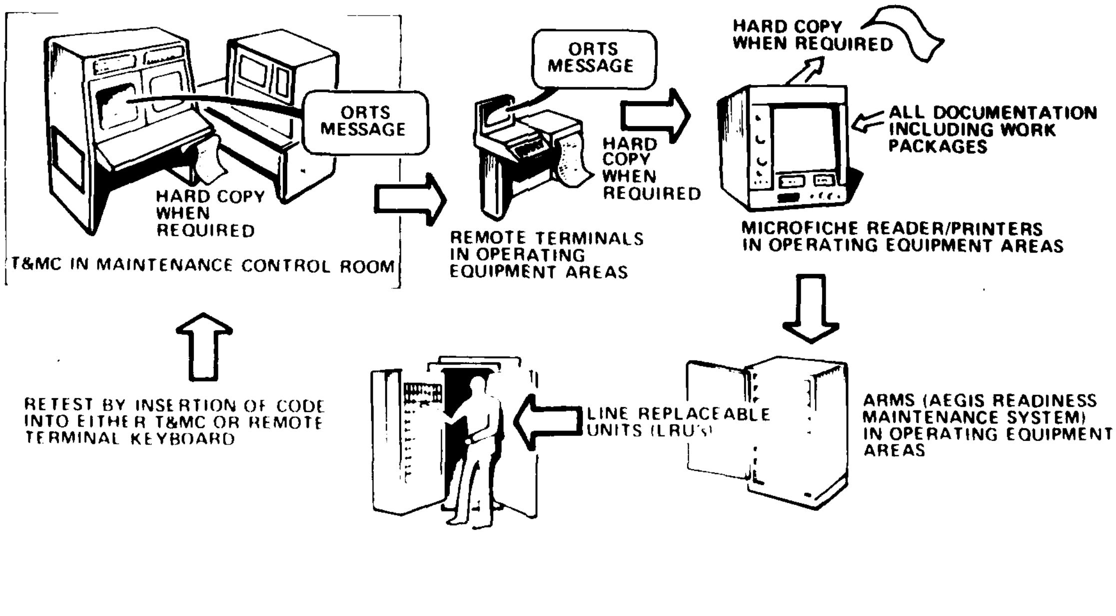


Figure 3. AEGIS Maintenance Sequence

- SYSTEM - LEVEL MAINTENANCE (LRU REMOVAL AND REPLACEMENT)

  18:36:54 FDT= >1.15.10.1.2< FR-T054055638 MFA-656VA7

- EQUIPMENT - LEVEL MAINTENANCE (MANUAL TROUBLESHOOTING)

  20:42:10 FDT= >1.5.4.14< FR-T02006196M15 MFA-426VE10

FDT = FAULT DETECTION TEST

FR = FAULT RESULT NO.

MFA = MICROFICHE ADDRESS

Figure 4. ORTS Failed-Item Alert Messages

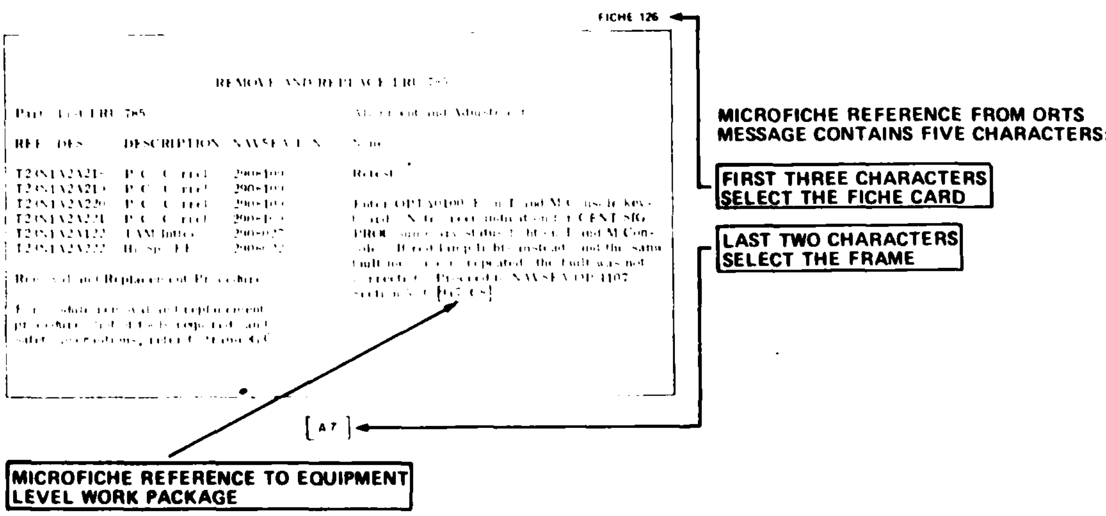


Figure 5. Sample System — Level Work Package

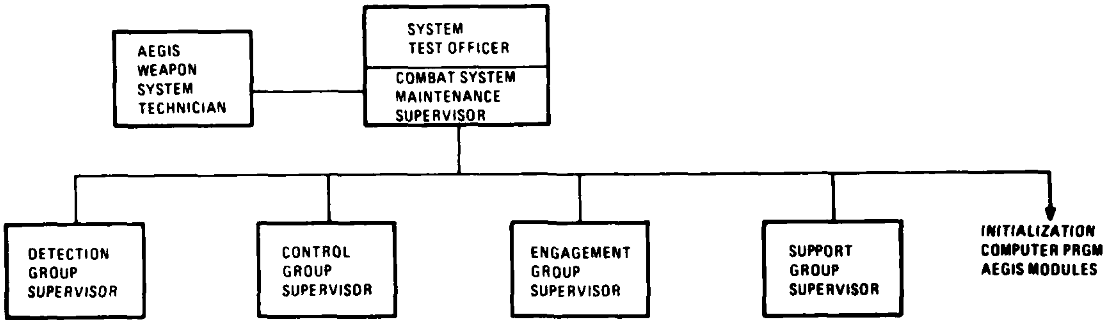


Figure 6. AEGIS Maintenance Manual Hierarchy

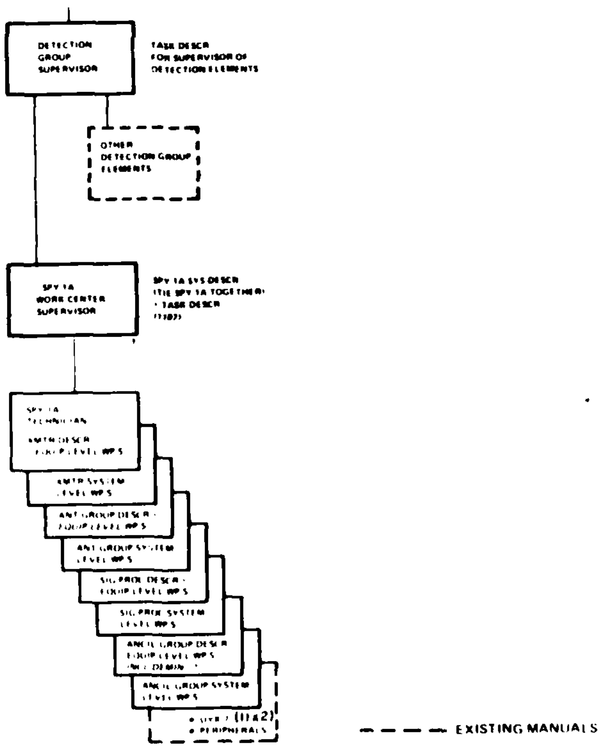


Figure 7. AEGIS Maintenance Manual Hierarchy (Continued)

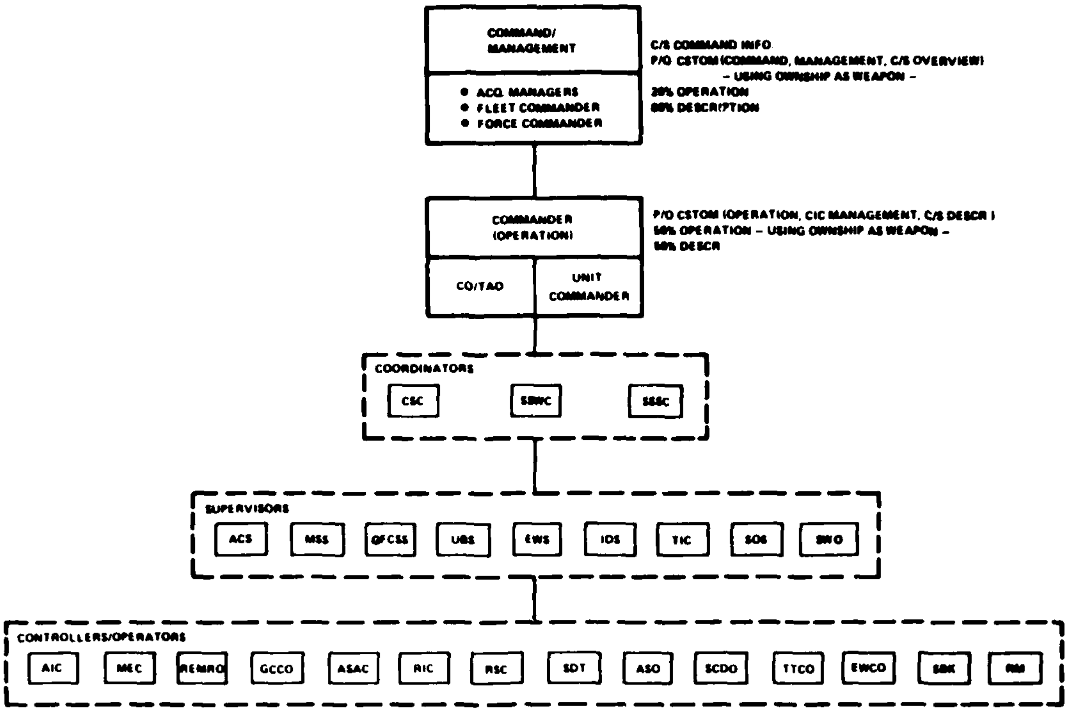


Figure 8. Concept Definition, Operational Managements

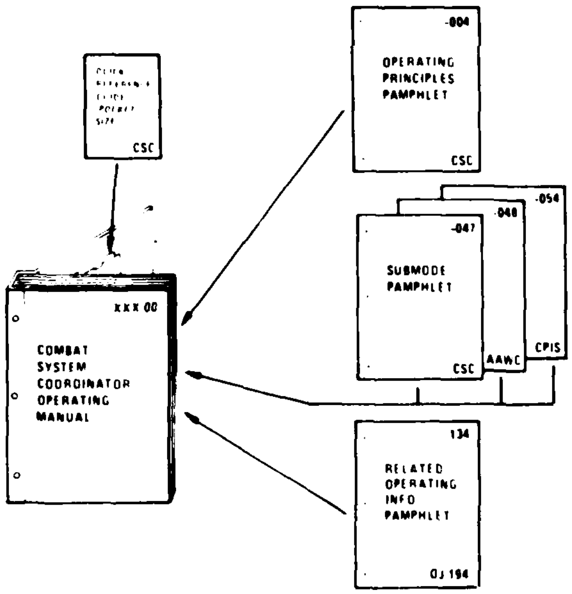


Figure 9. Pamphlets for CSC Operating Manual

ARMY (MIRADCOM) INITIATIVE IN TAILORING SPECIFICATIONS AND STANDARDS ON CONTRACTS TO ELIMINATE REDUNDANCY

PRESENTED BY: C. F. GOESSLING

PREPARED BY: H. R. LOWERS
DIRECTOR, ENGR LAB
USAMIRADCOM

AND

T. HARRISON
COMMAND DMO
USAMIRADCOM

SUMMARY

THIS PRESENTATION PROVIDES AN OVERVIEW OF THE SPECIFICATIONS AND STANDARDS APPLICATION PROGRAM AT THE US ARMY MISSILE RESEARCH AND DEVELOPMENT COMMAND (MIRADCOM), REDSTONE ARSENAL, AL. THE PRESENTATION IS BASED ON THE ARMY POLICY CONTAINED IN AR 700-70 AND AS CITED IN APPENDIX 1. THE SPECIFICATIONS AND STANDARDS APPLICATION PROGRAM AT MIRADCOM IS ASSIGNED TO THE COMMAND DATA MANAGEMENT OFFICER (DMO).

IT SHOULD BE MADE CLEAR THAT THE MIRADCOM PROGRAM IS THE MIRADCOM IMPLEMENTATION OF AR 700-70. ALL ARMY COMMANDS ARE DIFFERENT; THEREFORE, DIFFERENCES IN PROGRAM IMPLEMENTATION EXIST. EACH ARMY COMMAND HAS IMPLEMENTED THE SPECIFICATIONS AND STANDARDS PROGRAM POLICIES WITH SLIGHTLY DIFFERENT CONCEPTS.

TEXT

MY PRESENTATION DOES NOT CONTAIN ANYTHING NEW, WE AT MIRADCOM (AND FORMERLY MICOM) HAVE USED THIS APPROACH SINCE 1968. SOME OF THE TERMS HAVE CHANGED OVER THE YEARS AND TIGHTER CONTROLS HAVE BEEN IMPOSED, BUT, THE BASIC PROGRAM HAS REMAINED UNCHANGED.

I FEEL THAT AFTER I HAVE FINISHED YOU WILL AGREE THAT WE ARE ONLY USING A COMMON SENSE APPROACH.

I

PROCEDURES

TO MAKE ANY PROGRAM WORK, A METHOD, PLAN OR TECHNIQUE MUST BE DEVELOPED AND FOLLOWED. AT MIRADCOM WE FELT THAT, IN ORDER TO KEEP OUR REQUIREMENTS (DATA AND ACQUISITION MANAGEMENT SYSTEMS) AT A MINIMUM, WE MUST FIRST DECIDE TO WHAT DEGREE THE PROGRAM AT MIRADCOM SHOULD BE CONTROLLED.

IT WAS EVIDENT, THAT WITH THE EMPHASIS PLACED ON DATA MANAGEMENT AT THE TIME, THAT FIRM CONTROLS WOULD HAVE TO BE INVOKED. THE ASSIGNED COMMAND DMO WAS HELD RESPONSIBLE FOR DEVELOPING AND IMPLEMENTING A PROGRAM THAT WOULD INSURE THAT MICOM (LATER MIRADCOM) REQUIRED ONLY THE MINIMUM ACQUISITION MANAGEMENT SYSTEMS AND DATA REQUIREMENTS.

THE FIRST STEP WAS TO DETERMINE HOW WE COULD INSURE THAT ONLY THE MINIMUM REQUIREMENTS WERE CITED IN RFP'S AND SUBSEQUENT CONTRACTS. THE ARMY DID REQUIRE REVIEWS ON CONTRACTS EXCEEDING CERTAIN DOLLARS BY A DATA REQUIREMENTS REVIEW BOARD (DRRB). WE AT MICOM FOUND THE ARMY POLICY TO BE LACKING

IN THE CONTROLS NEEDED TO INSURE PROPER REVIEWS SO WE IMPLEMENTED A FEW OF OUR OWN. WE FIRST REORGANIZED OUR DATA REQUIREMENTS REVIEW BOARD BY APPOINTING ONLY TOP MANAGEMENT TO THE BOARD CHAIRED BY THE CHIEF ENGINEER (LATER DIRECTOR OF ENGINEERING, MIRADCOM). THEN WE SET THE TYPES OF EFFORTS TO BE REVIEWED. WE PLACED IMPORTANCE ON THE EFFORT RATHER THAN THE DOLLAR VALUE. OUR DRRB REVIEWS ALL ADVANCED DEVELOPMENT, ENGINEERING DEVELOPMENT AND FIRST PRODUCTION EFFORTS. <u>ALL OTHERS ARE REVIEWED BY THE COMMAND DMO</u>.

THE SECOND STEP WAS TO DEVELOP AN OUTLINE OF HOW A RFP/CONTRACT STATEMENT OF WORK SHOULD BE STRUCTURED AND ITS BASIC CONTENTS. ALONG WITH THIS A METHOD OF DETERMINING AND JUSTIFYING REQUIREMENTS WAS DEVELOPED. THIS REQUIRED THE PROGRAM MANAGER TO DEVELOP HIS PRELIMINARY WORK BREAKDOWN STRUCTURE (WBS) AND PRELIMINARY SYSTEM SPECIFICATION PRIOR TO THE PREPARATION OF THE STATEMENT OF WORK.

THE FORMAT IN WHICH WE REQUIRE ALL ADVANCED AND ENGINEERING DEVELOPMENT EFFORTS TO BE PREPARED IS SHOWN IN <u>APPENDIX 2</u>. THE OUTLINE COVERS ALL POSSIBLE REQUIREMENTS SO IT MUST BE TAILORED TO EACH PROGRAM BASED ON THE PROGRAM PRELIMINARY WBS AND SYSTEM SPECIFICATION. ADVANCED DEVELOPMENT REQUIREMENTS GENERALLY ARE NOT BROKEN BELOW THE SECOND WBS LEVEL.

THE PRIMARY METHOD MIRADCOM USES TO OBTAIN FROM THE FUNCTIONAL AREAS THE INFORMATION AND REQUIREMENTS NEEDED TO ASSURE THAT ADEQUATE INPUTS ARE FURNISHED IS THE DATA CALL. <u>APPENDIX 3</u> IS A TYPICAL FORMAT FOR DATA CALLS. INCLUDED IN THIS CALL IS THE REQUIREMENT TO APPLY ONLY THE MINIMUM ESSENTIAL SPECIFICATIONS AND STANDARDS.

Specifications and Standards imposed must be certified as shown in Appendix 4. Certification is at the supervisory level.

The RFP/Contract Attachment at Appendix 5 serves two purposes in the RFP/Contract. (1) It satisfies the requirements of ASPR 1-1201 and (2) it puts into one place a listing of all specifications and standards imposed, whether they have been tailored and a reference to where they are imposed.

The third step was to determine the RFP flow. The flow as seen in Appendix 6 provides the DMO with correct review steps and also depicts the reviews a procurement package is subjected to.

The MIRADCOM DRRB and Command DMO are not overly concerned with reviewing the DD Form 1423. We check to make sure its complete and only calls out those data required by the statement of work. We are highly concerned with the requirements, or tasks, set forth in the Statement of Work. They drive the data.

II
APPLICATION OF SPECIFICATIONS AND STANDARDS

Now you know basically how MIRADCOM determines and controls their RFP requirements. The Application of Specifications and Standards is an integral part of the MIRADCOM Data Management Program. But what is it?

APPLICATION IS DEFINED IN AR 700-70 AS: "THE ORDERLY PROCESS OF REVIEWING AND SELECTING FROM THE TOTAL REALM OF AVAILABLE SPECIFICATIONS AND STANDARDS THOSE THAT ARE CONSIDERED TO HAVE APPLICATION TO THE PARTICULAR MATERIEL ACQUISITION PROGRAM AND CONTRACTUALLY INVOKING THESE WHOLLY, OR IN PART, AT THE MOST ADVANTAGEOUS STATUS POINT IN THE SYSTEM DEVELOPMENT CYCLE."

WHY SO MUCH INTEREST AND EMPHASIS ON THE PROPER APPLICATION OF SPECIFICATIONS AND STANDARDS? THE ANSWER IS BETTER EXPLAINED IN THE DEFENSE SCIENCE BOARDS' "REPORT OF THE TASK FORCE ON SPECIFICATIONS AND STANDARDS" DATED APRIL 1977, BETTER KNOWN AS THE SHEA REPORT. IF YOU HAVEN'T READ IT, I HIGHLY RECOMMEND YOU DO SO. FOR YOUR BENEFIT I HAVE EXTRACTED, AT APPENDIX Z, THE SHEA FINDINGS AND THE RECOMMENDATIONS FOR IMPROVED APPLICATION.

BASED ON THE SHEA FINDINGS, IT BECOMES APPARENT WHY THE INTEREST AND EMPHASIS IS ON THE PROPER APPLICATION OF SPECIFICATIONS AND STANDARDS.

THE PROPER APPLICATION OF SPECIFICATIONS AND STANDARDS SHOULD BEGIN AS EARLY AS POSSIBLE IN THE PROGRAM LIFE CYCLE. DECISIONS CAN BE MADE AS TO WHEN FORMAL APPLICATION OF SPECIFICATIONS AND STANDARDS ARE REQUIRED AND HOW THAT APPLICATION MUST PROGRESS BY CHARTING THE PROGRAM MILESTONES AND DETERMINING THE PROGRAM TYPE DESIGNATOR DURING THE PROGRAM INITIATION PHASE.

THE PROPER APPLICATION OF SPECIFICATIONS AND STANDARDS IS THE RESPONSIBILITY OF THE INDIVIDUAL OR ORGANIZATION IMPOSING THE REQUIREMENT. HOWEVER, CONTROLS MUST BE IMPOSED AT THE COMMAND LEVEL (AS DESCRIBED EARLIER) TO PREVENT MISAPPLICATION.

BEFORE I GO INTO SOME OF THE METHODS OF APPLICATION LET ME SAY THAT I HAVE AVOIDED USING THE TERM "TAILORING" INTENTIONALLY. TAILORING IS ONLY ONE METHOD IN THE APPLICATION PROCESS AND IT IS NOT THE INTENT OR DESIRE OF MIRADCOM TO TAILOR SPECIFICATIONS AND STANDARDS. THE MIRADCOM PROGRAM IS THE PROPER APPLICATION OF SPECIFICATIONS AND STANDARDS AS DESCRIBED IN THE DEFINITION FOR APPLICATION IN AR 700-70.

THERE ARE MANY WAYS TO APPLY SPECIFICATIONS AND STANDARDS, SOME OF WHICH ARE SHOWN IN APPENDIX 8. MIRADCOM PRIMARILY PUSHES THE "EXCEPTION METHOD" ALTHOUGH SOME GOOD USE OF THE "REWRITE METHOD" IS MADE. EXTRACTS OF ACTUAL EXAMPLES ARE INCLUDED IN APPENDICES 9 THRU 13.

WE HAVE STARTED THE SPECIFICATIONS AND STANDARDS APPLICATION PROGRAM WITH A GOOD FOUNDATION; HOWEVER, IN ORDER TO PROCESS, THE SHEA RECOMMENDATIONS, APPENDIX 14, MUST BE ENACTED, ACCEPTED AND ENFORCED.

I HOPE I HAVE CONVINCED YOU THAT DEFENSE AGENCIES ARE PLACING EMPHASIS ON SPECIFYING ONLY MINIMUM ESSENTIAL REQUIREMENTS. IN TWO RECENT INSTANCES, WE AT MIRADCOM ASKED INDUSTRY TO COMMENT ON OUR DATA REQUIREMENTS BY MEANS OF A DRAFT REQUEST FOR PROPOSALS (RFP). WE RECEIVED LITTLE IN THE WAY OF SUGGESTIONS. EITHER WE ARE DOING A GOOD JOB, OR YOU ARE FAILING TO CHALLENGE US. THIS EFFORT NEEDS TO BE A TWO-WAY STREET. WE ARE AWARE THAT NEITHER GOVERNMENT NOR INDUSTRY CAN AFFORD SOME OF THE LUXURIES OF THE PAST. I SOLICIT YOUR CONTINUED ASSISTANCE.

ARMY POLICY

AR 700–70

SPECIFICATIONS AND STANDARDS USED IN MATERIAL ACQUISITION PROGRAMS WILL BE SELECTIVELY APPLIED AND TAILORED TO IMPOSE THE MINIMUM ESSENTIAL NEEDS. GENERALLY, THE APPLICATION AND TAILORING OF SPECIFICATIONS AND STANDARDS AS INTENDED HEREIN PERTAINS TO NONPRODUCT SPECIFICATIONS AND STANDARDS

ARMY POLICY

(AR 700–70)

- MANAGEMENT CONTROLS OVER USE OF SPECS AND STDS AND DATA ITEM DESCRIPTIONS TO ASSURE COST EFFECTIVE TAILORING
- CONTROL OF UNRESTRICTED IMPOSITION OF TOTAL SPECS AND STDS
- DATA ITEM DESCRIPTIONS TO BE CONSISTENT WITH THE TAILORED SOURCE SPEC OR STD
- ESTABLISHMENT OF PROCEDURES TO PROVIDE FEEDBACK FROM PROSPECTIVE CONTRACTORS
- MAINTENANCE OF TAILORING REVIEWS AND RECORDS
- FUNCTIONAL SUPPORT GROUPS TO STRUCTURE SYSTEM AND EQUIPMENT REQUIREMENTS TO BE CONSISTENT WITH ARMY POLICY ON TAILORING
- REVIEW BOARD VERIFICATION OF TAILORING
- IMPOSED REQUIREMENTS TO BE CHALLENGED

ENGINEERING DEVELOPMENT
SCOPE OF WORK

	WBS LEVEL					
CLIN/PARA NO.	1	2	3	4	5	NOMENCLATURE
0001	X					SYSTEM (DESCRIPTION)
0001AA		X				MISSILE
0001AA.1			X			(THIRD LEVEL TO BE DETERMINED BY ORIGINATOR IN ACCORDANCE WITH MIL–STD 881 & AR 70–32)
0001AB		X				GROUND SUPPORT EQUIPMENT
0001AB.1			X			(THIRD LEVEL TO BE DETERMINED BY ORIGINATOR)
0001AC		X				TRAINING
0001AC.1			X			NEW EQUIPMENT TRAINING
0001AC.2			X			TRAINING SERVICES
0001AC.3			X			TRAINING FACILITIES
0001AD		X				PECULIAR SUPPORT EQUIPMENT
0001AE		X				SYSTEM TEST AND EVALUATION
0001AE.1			X			DEVELOPMENT TEST
0001AE.1.1				X		DESIGN TESTS
0001AE.1.2				X		PREQUALIFICATION/RELIABILITY TESTS
0001AE.1.3				X		HUMAN FACTORS ENGINEERING TESTS
0001AE.1.4				X		SAFETY TESTS
0001AE.1.5				X		SYSTEM ASSESSMENT EVALUATION
0001AE.2			X			TECHNICAL EVALUATION
0001AE.3			X			TEST AND EVALUATION SUPPORT
0001AE.4			X			OPERATIONAL EVALUATION
0001AE.5			X			MOCK–UPS
0001AE.6			X			TEST FACILITIES

SCOPE OF WORK

	WBS LEVEL					
CLIN/PARA NO.	1	2	3	4	5	NOMENCLATURE
0001AF		X				PROGRAM MANAGEMENT
0001AF.1			X			SYSTEM ENGINEERING
0001AF.1.1				X		SYSTEM INTEGRATION
0001AF.1.2				X		HUMAN FACTORS
0001AF.1.3				X		SAFETY
0001AF.1.4				X		CONFIGURATION MANAGEMENT
0001AF.1.5				X		DETERIORATION PREVENTION
0001AF.1.6				X		PRODUCT CLEANLINESS REQUIREMENTS
0001AF.1.7				X		METRICATION
0001AF.2			X			DESIGN–TO–COST MANAGEMENT
0001AF.3			X			DATA MANAGEMENT
0001AF.4			X			PRODUCT ASSURANCE
0001AF.4.1				X		QUALITY ASSURANCE
0001AF.4.2				X		RELIABILITY
0001AF.4.3				X		MAINTAINABILITY
0001AF.4.4				X		SYSTEM ASSESSMENT
0001AF.4.5				X		RAM
0001AF.6			X			LOGISTICS
0001AF.7			X			DESIGN REVIEWS
0001AG		X				DATA
0001AG.2			X			ENGINEERING DATA
0001AG.2.1				X		ENGINEERING DRAWINGS
0001AG.2.2				X		SPECIFICATIONS
0001AG.2.7				X		TRANSPORTABILITY DATA
0001AG.2.8				X		SAFETY DATA
0001AG.2.9				X		HUMAN FACTORS ENGINEERING DATA
0001AG.2.10				X		PRODUCT ASSURANCE DATA

SCOPE OF WORK

	WBS LEVEL					
CLIN/PARA NO.	1	2	3	4	5	NOMENCLATURE
0001AG.2.10.1					X	QUALITY
0001AG.2.10.2					X	RELIABILITY
0001AG.2.10.3					X	MAINTAINABILITY
0001AG.2.10.4					X	PRODUCT ASSESSMENT
0001AG.3			X			MANAGEMENT DATA
0001AG.3.1				X		WORK BREAKDOWN STRUCTURE
0001AG.3.2				X		OTHER
0001AG.4			X			LOGISTICS DATA
0001AG.4.1				X		MEADS/LSA
0001AH		X				SPARES
0001AI		X				INDUSTRIAL FACILITIES
0001AJ		X				OPERATIONAL/SITE ACTIVATION
0001AK		X				COMMON SUPPORT EQUIPMENT

DATA CALL
SCOPE OF WORK, DD FORMS 1423
DD FORMS 1660, DD FORMS 1664,
ADDENDA

FROM: DATE:

TO: DRXHC–MI (HUMAN FACTORS ENGINEERING)
DRDMI–QP (QUALITY, RAM, RELIABILITY, MAINTAINABILITY)
DRDMI–EA (PRODUCIBILITY, ENGINEERING PLANNING)
DRDMI–ESD (ENG DWGS, STANDARDIZATION, NOMENCLATURE, SPECIFICATIONS, CM)
DRDMI–DC (WBS, FINANCIAL REG, DESIGN–TO–COST)
DRDMI–ET (TEST)
DRDMI–T
DRDMI–DP (ALL MIRCOM REQUIREMENTS, i.e., PUBS, PROVISIONING, PACKAGING, SAFETY, TRANSPORTABILITY, TRAINING, LSA, ETC.)

SYSTEM:

LENGTH OF CONTRACT:
DOLLAR VALUE:
TYPE CONTRACT: (ENG SVCS, AD, ED, ETC.)
CONTRACTOR (IF KNOWN).
DD FORM 1660 REQUIRED:
DATE REQUIREMENTS NEEDED:
TARGET DATE FOR CONTRACT:
IDENTIFY TYPE REVIEW REQUIRED: (DRRB ETC.)

IDENTIFICATION OF EFFORT:

ADDITIONAL REMARKS:

NOTE: SCOPE OF WORK SHALL BE PREPARED IN ORIGINAL (AD&ED SOW WILL FOLLOW WBS FORMAT OUTLINE). DD FORMS 1423 MAY BE IN DRAFT PROVIDED ALL INFORMATION IS AVAILABLE. DD FORMS 1660 MAY ALSO BE DRAFT. DD FORMS 1664 NEED NOT BE ATTACHED UNLESS MODIFICATION HAVE BEEN MADE (ADDENDA IS NOT CONSIDERED MODIFICATION).

SIGNATURE OF INITIATOR TELEPHONE NO.

SPECIFICATION/STANDARD CERTIFICATION

DIRECTORATE/OFFICE:____________________________

SUBMITTED BY:__________________________________

OFFICE SYMBOL:_________________________________

TELEPHONE NO:__________________________________

THE SPECIFICATIONS/STANDARDS LISTED BELOW ARE THE MINIMUM ESSENTIAL REQUIREMENTS OF THIS DIRECTORATE/OFFICE. EACH SPECIFICATION/STANDARD HAS BEEN THOROUGHLY REVIEWED AND ONLY THE SPECIFIC REQUIREMENTS HAVE BEEN CITED.

EACH TAILORED SPECIFICATION/STANDARD IS ANNOTATED WITH AN ASTERISK.

THE LIST CONTAINS ALL APPLICABLE FIRST TIER DOCUMENTS.

____

DIRECTOR/CHIEF

ATTACHMENT TO RFP/CONTRACT __________

SPECIFICATIONS/STANDARDS APPLICATION LIST

THE FOLLOWING FIRST TIER SPECIFICATIONS/STANDARDS OF THE ISSUE STATED ARE HEREBY APPLICABLE TO THE ____________________ SYSTEM RFP/CONTRACT NO. __________________. IN ADDITION, AND UNLESS OTHERWISE STATED, ALL DOCUMENTS SPECIFIED IN PARAGRAPH 2 OF THE FIRST TIER DOCUMENTS ARE OF THE ISSUE CONTAINED IN THE DEPARTMENT OF DEFENSE INDEX OF SPECIFICATIONS AND STANDARDS (DODISS) DATES 1 JULY 1978 WITH SUPPLEMENT DATED ____________.

DOCUMENT NUMBER	REVISION	DATE	NOMENCLATURE	RFP/ CONTACT REFERENCE

*DENOTES DOCUMENT THAT HAS BEEN TAILORED. RFP/CONTRACT REFERENCE WILL LIMIT DOCUMENT APPLICABILITY.

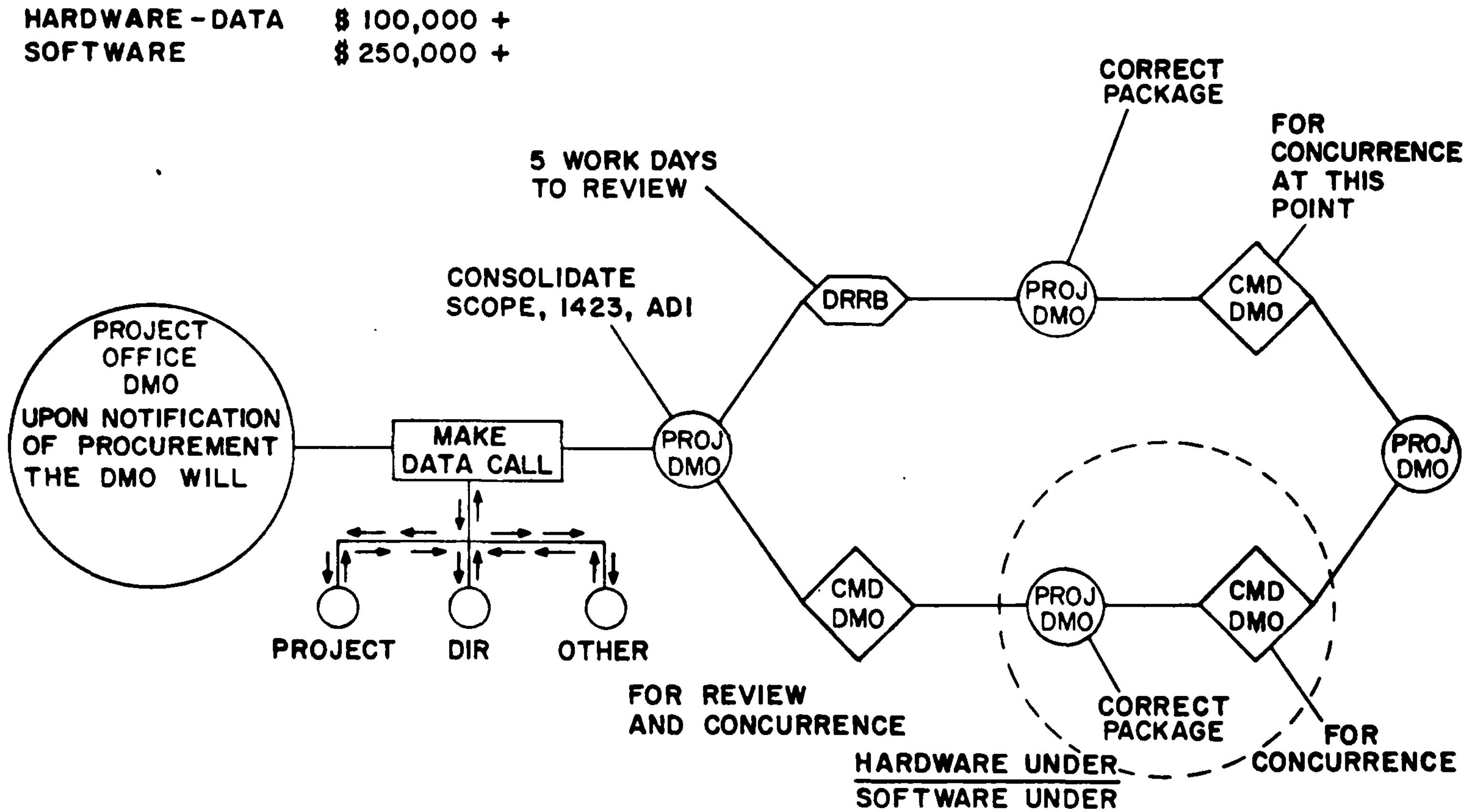
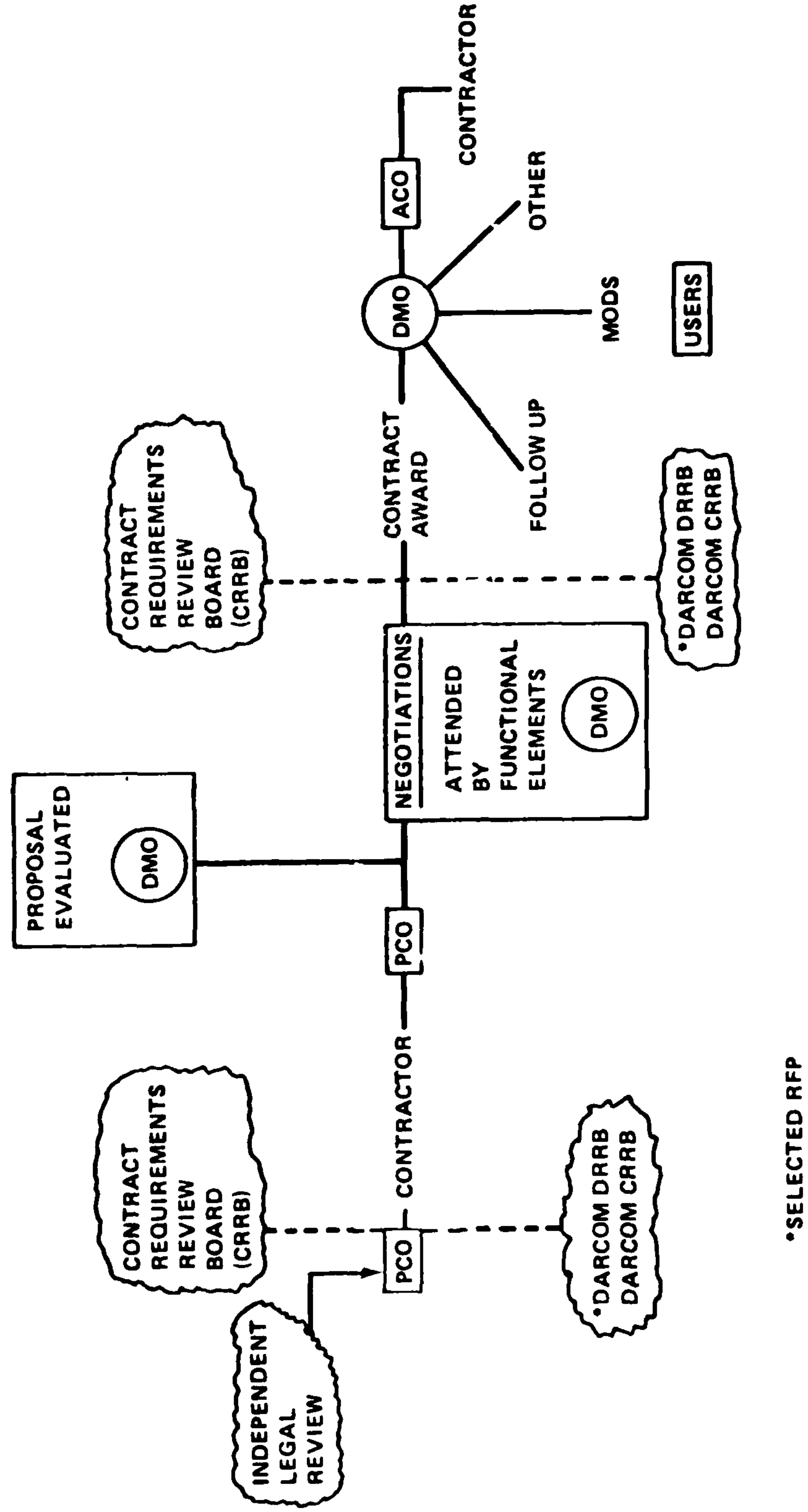


Figure G-1. Phase I (procurement) data requirements package flow.



INDEPENDENT LEGAL REVIEW
CONTRACT REQUIREMENTS REVIEW BOARD (CRRB)
PCO
*DARCOM DRRB DARCOM CRRB
CONTRACTOR
PCO
PROPOSAL EVALUATED
DMO
NEGOTIATIONS
ATTENDED BY FUNCTIONAL ELEMENTS
DMO
CONTRACT REQUIREMENTS REVIEW BOARD (CRRB)
*DARCOM DRRB DARCOM CRRB
CONTRACT AWARD
DMO
FOLLOW UP
MODS
OTHER
ACO
CONTRACTOR
USERS
*SELECTED RFP

SHEA RECOMMENDATIONS
IMPROVED APPLICATIONS

A. LIFE CYCLE TAILORING

B. PREPARE APPLICATION GUIDELINES

C. IDENTIFY AND TAILOR "COST DRIVER" SPEC/STDS

D. ENCOURAGE CONTRACTORS TO SUBMIT COST-EFFECTIVE ALTERNATES

E. ELIMINATE PRO-FORMA PLANS

F. DEVELOP CONTRACTUAL INCENTIVES TO ENCOURAGE TAILORING

G. CONTROL PROLIFERATION OF NON-DODISS TECH REQUIREMENTS DOCUMENTS

SHEA REPORT RECOMMENDATIONS
IMPROVED APPLICATIONS (CONT'D)

I. DOD SHOULD INCORPORATE, IN ASPR AND IN ITS PLANNED POLICY ON APPLICATIONS TAILORING, PROVISIONS WHICH REQUIRE SPECIFIC MANAGEMENT ATTENTION, CONTROLS AND LIMITS OVER THE INCORPORATION OF DOCUMENTS CALLED OUT BY REFERENCE IN OTHER CITED REQUIREMENTS DOCUMENTS.

J. FOR THE ABOVE RECOMMENDATIONS TO BE EFFECTIVE, DOD MUST INSTITUTE A VIGOROUS CAMPAIGN TO EDUCATE BOTH GOVERNMENT AND CONTRACTOR PERSONNEL AND TO PUBLICIZE THE INTENT OF DIRECTIVES ISSUED TO IMPLEMENT THE *IMPROVED CLIMATE OF* APPLICATION.

"COST DRIVER" AREAS
GREATEST POTENTIAL – MISAPPLICATION OF SPECIFICATIONS & STANDARDS

- GENERAL DESIGN REQUIREMENTS
- CONFIGURATION MANAGEMENT
- HUMAN ENGINEERING/SAFETY
- RELIABILITY – MAINTAINABILITY
- QUALITY ASSURANCE
- ENVIRONMENTAL REQUIREMENTS & TEST METHODS
- DOCUMENTATION/STANDARDIZATION
- PACKING, PACKAGING, PRESERVATION, TRANSPORT
- INTEGRATED LOGISTICS
- MANUFACTURING PROCESSES/METHODS

METHODS OF TAILORING
(HOW)

- USE EXCEPTIONS
- REWRITE PARAGRAPHS
- SPECIFY QUANTIFIED REQUIREMENTS
- SUPPLEMENT
- USE THE SPEC/STD AS A GUIDE

NOTE: ASPR 1 – 1201 ALLOWS ONLY DOWNWARD TAILORING OF SPEC/STD.

APPLICATION OF SPECS/STDS
HOW (MIRADCOM)

1. BY IMPOSING ONLY THE MINIMUM ESSENTIAL REQUIREMENT ON THE CONTRACTOR.
2. BY INSURING THAT THE REQUIREMENT IMPOSED IS COMPATIBLE WITH THE SYSTEM LIFE CYCLE.
3. BY ALLOWING SUFFICIENT LEAD TIME IN ORDER THAT THE CONTRACTOR CAN PERFORM THE FUNCTION ROUTINELY.
4. BY SPECIFICS RATHER THAN GENERALITIES, THUS DECREASING THE POSSIBILITY OF CHANGE.
5. BY NOT REQUIRING PRELIMINARY SUBMITTALS OF DATA, ESPECIALLY FROM CONTRACTORS WHO HAVE HAD PREVIOUS MIRADCOM CONTRACTS.

PROGRAM MILESTONES

O – PROGRAM INITIATION PHASE

I – DEMONSTRATION AND VALIDATION

II – FULL–SCALE ENGINEERING DEVELOPMENT

III – PRODUCTION AND DEPLOYMENT

PROGRAM TYPE DESIGNATORS

I – COMPLEX, HIGH QUANTITY

II – NONCOMPLEX, HIGH QUANTITY

III – COMPLEX, LOW QUANTITY

IV – NONCOMPLEX, LOW QUANTITY

U.S. ARMY
MISSILE
RESEARCH
AND
DEVELOPMENT
COMMAND

SCOPE OF WORK

GENERAL SUPPORT ROCKET SYSTEM

VALIDATION PHASE

Redstone Arsenal, Alabama 35809

17 JANUARY 1977

DMI FORM 1000, 1 APR 77

0001AF.1.C. HUMAN FACTORS ENGINEERING (PAGES 29, 30 & 31 GSRS SOW)

1. A HUMAN FACTORS ENGINEERING PROGRAM SHALL BE PLANNED AND IMPLEMENTED IN ACCORDANCE WITH MIL–H–46855, AS APPLIED TO THE GSRS VALIDATION PHASE OBJECTIVES, CHARACTERISTICS AND CONSTRAINTS, WITH THE FOLLOWING EXCEPTIONS (PARAGRAPH NUMBERS IN a. THRU m. BELOW ARE THOSE IN MIL–H–46855A, DATED 2 MAY 1972):

   a. PARAGRAPH 3.1.2.1 – DELETE "IN ACCORDANCE WITH 3.3" FROM THE SECOND SENTENCE. DELETE THE THIRD SENTENCE AND SUBSTITUTE THE FOLLOWING "THE HUMAN ENGINEERING PROGRAM PLAN SHALL BE DIRECTED TOWARD HUMAN ENGINEERING REQUIREMENTS FOR THE FULL SCALE DEVELOPMENT PHASE."

   b. PARAGRAPH 3.1.2.2 – DELETE.

   c. PARAGRAPH 3.1.2.3 – DELETE.

   d. PARAGRAPH 3.2 – THIS PARAGRAPH APPLIES ONLY TO THE EXTENT THAT DETAIL DESIGN, DESIGN REVIEWS AND ENGINEERING CHANGE PROPOSAL REVIEWS ARE APPLICABLE DURING THE VALIDATION PHASE PROGRAM.

HUMAN FACTORS ENGINEERING (CONT'D)

   e. PARAGRAPH 3.2.2.2 – FOR PURPOSES OF THIS PROVISION, "DETAIL DESIGN" REFERS TO ANY DESIGN OF EQUIPMENT TO BE DEVELOPED IN ACCORDANCE WITH REQUIREMENTS OF THE CONTRACT, REQUIRING INTERFACING WITH PERSONNEL FOR OPERATION, CONTROL AND MAINTENANCE.

   f. PARAGRAPH 3.2.2.3 – DELETE "DETAIL" IN THE FIRST SENTENCE. DELETE SUBPARAGRAPH e.

   g. PARAGRAPH 3.2.3 – DELETE THE LAST SENTENCE.

   h. PARAGRAPH 3.2.4 – DELETE THE SENTENCES IN PARENTHESES.

   i. PARAGRAPH 3.2.4.1 – DELETE THE PORTION OF THE FIRST SENTENCE STARTING WITH "AND SHALL BE INTEGRATED INTO."

   j. PARAGRAPH 3.2.4.2 – DELETE FROM THE FIRST SENTENCE THE PHRASE "CONTAINED IN APPROVED TEST PLAN." DELETE THE SECOND SENTENCE.

   k. PARAGRAPH 3.3 – DELETE.

   l. PARAGRAPH 3.4 – DELETE.

   m. PARAGRAPH 3.5 – DELETE.

HUMAN FACTORS ENGINEERING (CONT'D)

2. THE HUMAN FACTORS ENGINEERING PROGRAM SHALL INCLUDE, BUT NOT NECESSARILY BE LIMITED TO, THE FOLLOWING:

   a. STUDIES AND ANALYSES – HUMAN FACTORS ENGINEERING ANALYSES SHALL INCLUDE DEFINITION AND ALLOCATION OF SYSTEM FUNCTIONS TO THE DEGREE APPLICABLE TO GSRS DEVELOPMENT, PRELIMINARY EQUIPMENT IDENTIFICATION, ANALYSIS OF TASKS AND PRELIMINARY SYSTEM DESIGN.

      HUMAN ENGINEERING PRINCIPLES, CRITERIA AND THE RESULTS OF TESTING SHALL BE APPLIED WITH OTHER DESIGN REQUIREMENTS TO IDENTIFY THE EQUIPMENT TO BE USED BY MAN. THE DESIGN CONFIGURATION SHALL REFLECT HUMAN FACTORS ENGINEERING INPUTS TO SATISFY THE SYSTEM PERFORMANCE REQUIREMENTS AND THE APPLICABLE CRITERIA OF MIL–STD–1472B.

   b. DETAILED DESIGN – HUMAN FACTORS ENGINEERING APPLICATION TO DETAILED DESIGN SHALL BE DIRECTED TOWARD SATISFYING REQUIREMENTS IN THAT AREA SPECIFIED BY MIL–H–46855 IN GENERAL AND TOWARD THE FOLLOWING CRITICAL FUNCTIONS IN PARTICULAR:

      (1) SPLL DESIGN – MAN/MACHINE INTERFACE DESIGNED TO MINIMIZE CREW SIZE AND PHYSICAL EFFORT REQUIRED TO MEET SPECIFIED REACTION TIME.

      (2) CREW TASK SEQUENCE – GSRS FIRING AND RELOAD.

HUMAN FACTORS ENGINEERING (CONT'D)

      (3) FIRING ENVIRONMENT – NOISE PER CRITERIA OF MIL–STD–1474A, HIGH VELOCITY PARTICLES, VISIBLE ENERGY, EXHAUST PRODUCTS AND THERMAL ENERGY EFFECTS.

      (4) FIELD OPERATION – EFFECTS OF PERSONNEL EQUIPMENT, CLOTHING, CLIMATIC CONDITIONS, DEGRADED VISIBILITY/ILLUMINATION CONDITIONS, AND TERRAIN.

   c. HFE DESIGN CRITERIA – PERFORMANCE CRITERIA TO BE USED SHALL BE THAT HUMAN PERFORMANCE NECESSARY TO MEET OR EXCEED THE SYSTEM CAPABILITIES SPECIFIED BY MIS 26432. HFE DESIGN SHALL CONFORM TO APPLICABLE REQUIREMENTS MIL–STD–1472B, "HUMAN ENGINEERING DESIGN CRITERIA FOR MILITARY SYSTEMS, EQUIPMENT AND FACILITIES."

   d. HFE TEST AND EVALUATION – INTEGRATION OF HUMAN FACTORS ENGINEERING REQUIREMENTS INTO TESTING TO DEMONSTRATE (1) REACTION TIME FOR EMPLACEMENT, FIRE MISSION, RESUPPLY AND MARCH ORDER, (2) PERFORMANCE ACCURACY FOR CRITICAL TASKS AS DEFINED BY 6.2.1 OF MIL–H–46855A, AND (3) SUITABILITY OF DEVELOPED OPERATING PROCEDURES.

   e. FORMULATION OF A PROPOSED HUMAN FACTORS ENGINEERING PROGRAM PLAN FOR FULL SCALE DEVELOPMENT.

3.1.2.1	Human Engineering Program Plan
3.1.2.2	Changes to Human Engineering Program Plan
3.1.2.3	Other Data
3.2	Detail Requirements
3.2.2.2	Equipment Detail Design Drawings
3.2.2.3	Work Environment, Crew Stations and Facilities Design
3.2.3	Equipment Procedure Development
3.2.4	Human Engineering in Test and Evaluation
3.2.4.1	Planning
3.2.4.2	Implementation
3.3	Data Requirements
3.4	Data Availability
3.5	Drawing Approval

0001AF2.C. PRODUCT ASSURANCE (PAGES 34 & 35 GSRS SOW)

1. RELIABILITY PROGRAM. THE CONTRACTOR SHALL ESTABLISH AND MAINTAIN AN EFFECTIVE RELIABILITY PROGRAM THAT IS PLANNED, INTEGRATED, AND DEVELOPED IN CONJUNCTION WITH OTHER DESIGN, AND DEVELOPMENT FUNCTIONS TO PERMIT THE MOST ECONOMICAL ACHIEVEMENT OF MATERIEL RELIABILITY OBJECTIVES. THIS RELIABILITY PROGRAM SHALL BE CONDUCTED IN ACCORDANCE WITH EXHIBIT QR–800–F. THE FOLLOWING PARAGRAPHS OF QR–800–F ARE NOT REQUIRED: 4.2.1, 4.3., 5.1.4, 5.1.6, 5.2.7.2, 5.2.7.3, 5.3.2, 5.3.3, 5.3.5. IN ADDITION THE CONTRACTOR SHALL MONITOR AND ASSURE THAT ALL RELIABILITY PROGRAM TASKS ARE ACCOMPLISHED EFFECTIVELY. THE CONTRACTOR SHALL PREPARE A RELIABILITY PROGRAM PLAN IN ACCORDANCE WITH DI–R–1730 WHICH DESCRIBES THE SCHEDULES, METHODS AND RESOURCES TO BE USED IN THE ACCOMPLISHMENT OF THE TASKS REQUIRED BY EXHIBIT QR–800–F. THE CONTRACTOR SHALL IMPLEMENT AND CONDUCT A RELIABILITY PROGRAM IN ACCORDANCE WITH THE APPROVED RELIABILITY PROGRAM PLAN, DI–R–1730.

2. MAINTAINABILITY AND AVAILABILITY. THE CONTRACTOR SHALL PERFORM MAINTAINABILITY TRADE–OFF STUDIES TO EVALUATE MAINTENANCE REQUIREMENTS (FREQUENCY, TYPE, TIME) FOR SYSTEM COMPONENTS AND TO EVALUATE TRADE–OFFS BETWEEN ALTERNATIVE MAINTENANCE CONCEPTS (i.e., REPAIR VS THROWAWAY). THE MAINTAINABILITY AND AVAILABILITY REQUIREMENTS SPECIFIED IN PARAGRAPHS 3.2.4 AND 3.2.5 OF MIS–26432 SHALL BE VERIFIED BY AN IN–DEPTH ANALYSIS. THE ANALYSIS SHALL CONSIST OF MAINTAINABILITY MODELING AND PREDICTIONS IN ACCORDANCE WITH MIL–STD–470 AND MIL–HDBK–472 FOLLOWED BY MAINTAINABILITY AND AVAILABILITY ANALYSIS BASED ON PROGRAM TEST RESULTS. THESE ANALYSES SHALL BE REPORTED IN DI–R–1741. THE MAINTAINABILITY PROGRAM SHALL BE CONDUCTED IN ACCORDANCE WITH MIL–STD–470 AS AMENDED BY QR–870–B. THE FOLLOWING PARAGRAPHS OF QR–870–B ARE NOT REQUIRED: 4.3.1, 5.2.2 OF A.26, 5.2.3 OF A.2.6 AND A.2.12. THE CONTRACTOR SHALL PREPARE A MAINTAINABILITY PROGRAM PLAN IN ACCORDANCE WITH DI–R–1740 WHICH DESCRIBES THE METHODS, SCHEDULES AND RESOURCES TO BE USED IN THE ACCOMPLISHMENT OF THE TASKS REQUIRED BY EXHIBIT QR–870–B. THE CONTRACTOR SHALL IMPLEMENT AND CONDUCT A MAINTAINABILITY PROGRAM IN ACCORDANCE WITH THE APPROVED MAINTAINABILITY PROGRAM PLAN, DI–R–1740.

3. QUALITY. THE CONTRACTOR SHALL SUBMIT A QUALITY PROGRAM PLAN TO THE GOVERNMENT IN ACCORDANCE WITH DATA ITEM DI–R–1710 AND UPON APPROVAL SHALL IMPLEMENT AND MAINTAIN A QUALITY PROGRAM IN ACCORDANCE WITH THIS PLAN. THE QUALITY PROGRAM SHALL BE IN ACCORDANCE WITH MIL–Q–9858A.

QR 870

4.3.1	Quantitative Requirements
5.2.2 of A.2.6	Diagnostic Capability Analysis (DCA)
5.2.3 of A.2.6/A.2.12	Repair Method Analysis (RMA)

QR 800

4.2.1	Quantitative Requirements
4.3	Reliability Demonstration
5.1.4	Reliability Program Review
5.1.6	Reliability Growth Management
5.2.7.2	Engineering Design Changes
5.2.7.3	Reliability Analysis of Proposed Engineering Changes
5.3.2	Development Testing
5.3.3	Reliability Demonstration
5.3.5	Design Qualification

EXHIBIT: QR–800–H
30 SEP 1977

RELIABILITY PROGRAM FOR SYSTEMS AND EQUIPMENT DEVELOPMENT

U.S. ARMY
MISSILE
RESEARCH
AND
DEVELOPMENT
COMMAND

FOREWORD

1. THIS EXHIBIT CLARIFIES AND DEFINITIZES THE RELIABILITY PROGRAM REQUIREMENTS OF MIL–STD–785A, "RELIABILITY PROGRAM FOR SYSTEMS AND EQUIPMENT DEVELOPMENT AND PRODUCTION," DATED 28 MARCH 1969. THE PURPOSE OF THIS DOCUMENT IS TO SPECIFICALLY TAILOR AN ENGINEERING DEVELOPMENT PHASE RELIABILITY PROGRAM TO COMPLY WITH THE PROVISIONS OF ARMY REGULATION 702–3, "ARMY MATERIEL RELIABILITY, AVAILABILITY, AND MAINTAINABILITY (RAM)," 15 NOVEMBER 1976, AND TO BEST SATISFY THE SPECIAL REQUIREMENTS INHERENT IN MISSILE ROCKET, AND LASER WEAPON SYSTEMS AND SUPPORT SYSTEMS.

2. THE BASIC STRUCTURE AND PARAGRAPHING OF MIL–STD–785A REMAINS INTACT. FOR CONVENIENCE IN USE, THE COMPLETE BODY, SECTIONS 1 THROUGH 6 ARE INCLUDED AS REWRITTEN TEXT. THESE SECTIONS AS REWRITTEN CONSTITUTE FORMAL "EXCEPTIONS" TO MIL–STD–785A, WHEN THIS EXHIBIT IS INCLUDED AS PART OF A CONTRACT.

Redstone Arsenal, Alabama 35809

DIRECTORATE FOR
PRODUCT ASSURANCE

DMI FORM 1000. 1 APR 77

EXHIBIT QR–870–C
31 JAN 1977

MAINTAINABILITY PROGRAM FOR SYSTEMS AND EQUIPMENT DEVELOPMENT

U.S. ARMY MISSILE RESEARCH AND DEVELOPMENT COMMAND

FOREWORD

1. THIS EXHIBIT CLARIFIES AND DEFINITIZES THE MAINTAINABILITY PROGRAM REQUIREMENTS OF MIL–STD–470, "MAINTAINABILITY PROGRAM REQUIREMENTS," DATED 21 MARCH 1966. THE PURPOSE OF THIS DOCUMENT IS TO SPECIFICALLY TAILOR A DEVELOPMENT PHASE MAINTAINABILITY PROGRAM TO COMPLY WITH THE PROVISIONS OF ARMY REGULATION 702–3, "ARMY MATERIEL RELIABILITY, AVAILABILITY, AND MAINTAINABILITY (RAM)," AND TO BEST SATISFY THE SPECIAL REQUIREMENTS INHERENT IN MISSILE, ROCKET AND LASER WEAPON AND/OR SUPPORT SYSTEMS.

U.S. ARMY
MIRADCOM

Redstone Arsenal, Alabama 35809

PRODUCT ASSURANCE
DIRECTORATE

DMI FORM 1000, 1 APR 77

FUTURE NEEDS

1. FOCUS AND STRENGTHEN DOD MANAGEMENT OF SPECIFICATIONS, WITH INITIAL CONCENTRATION ON COST–DRIVING REQUIREMENTS.
2. IMPROVE FEEDBACK FROM USERS TO PREPARERS.
3. CONTROL SPECIFICATION GENERATION AND REVISION.
4. FOSTER INCREASED USE OF COMMERCIAL SPECS/STDS.
5. REFORMAT DOCUMENTS TO FACILITATE TAILORING.
6. DEVELOP NATIONAL STANDARDS WHICH SATISFY MILITARY REQUIREMENTS.
7. CHANGE IN PROPOSAL EVALUATION PROCESS.
8. CHANGE PERSONAL OPINIONS
9. TRAINING

ROBOTICS IN MANUFACTURING

VERN ESTES
General Electric Company

NOTE: This paper was transcribed from a recording of the session. Unfortunately, it was not possible to verify the spelling of robot brand names prior to the publication deadline.

I have commented that I probably have charge of the largest robotics laboratory in the United States. I presently have ten robots. That is of interest because in April of 1977 General Electric had only ten robots total. Today we have 53 operating robots and ten in my labs. As of May 31, during our seminar, we will have seventeen on display.

I think you should know where I come from: I am from a Corporate Consulting Services Group (an ivory tower, of sorts). My robotics laboratory happens to be in the oldest building in General Electric. I believe it's Edison's first building and was built in 1886--that's where the robots are. It is located in Schenectady, New York. I think Edison would be kind of proud of us.

Just a little bit about General Electric: we do make everything from turbines to toothbrushes--we cut the bristles, put them in the brushes and then trim them to length for our electric toothbrush.

Now where do we fit in the service organization. We are kind of a catalyst between all of the operating components in a very decentralized company. Probably for every component that you know in the General Electric Company, I would name ten other operating components that you don't know anything about.

The mission of my group is to assist the Company in maintaining a cost leadership through application of the latest advanced manufacturing technology. Today, one of the biggest buzz words is "robotics" and they are not the type that walk around the floor. We have a worldwide monitoring organization and that's how we pick up what others are doing in other countries. We try to keep track of what our competition is doing and try to get in at the right time on these new technologies.

We discovered what other companies in other countries were doing with robotics a couple of years ago. That triggered our interest and got us started in putting together this lab. I've given thirty-one presentations to my own company and surveyed forty-five of our operating components for application of robots. The big thing with robots and the reason for them today is our productivity is lagging in the United States in relation to other countries. I just came back from Japan as part of our worldwide monitoring program this last Saturday.

Another reason for our concern is that we have an awful lot of machine tools in the General Electric Company, probably as many as any other major manufacturing facility in the Unites States. We have been working on the thirty percent side of our machine tool productivity for years. We've doubled speeds and we've doubled speeds, that's like beating a dead horse, because that's only the thirty percent side. You've got to work on the seventy percent side, the nonproductive area, nonchip cutting, the handling of parts, getting there in a timely manner and things like this, tying everything together with computers. That's part of my operation--computer managed parts manufacturing--and robots fit right in.

The other reason for robots today is that it is a mature technology. People who tried to implement robots three, four, five years ago found many problems. Today, robots are very smart. In fact in my labs, I have two of the smartest robots in the world. I have the Cincinnati Milacron which happens to have a minicomputer and the new Puma which was developed for General Motors. The Puma has eight microprocessors in it. They are much easier to program than they used to be. You can store and access multiple programs; in other words if you have parts coming by on a conveyor you can do something different on each part as it comes by. If you are paint spraying for instance, the parts can all be of different configurations; they can even be of different color, because you've got many different programs that you can access. These robots will even keep up with a moving conveyor of varying speed and in some cases even if the conveyor reverses it will keep doing its particular function on that part. Up to seven axis of motion are possible and they are more accurate than they ever were.

There are many people calling these robots "universal transfer devices", "flexible automation", etc. All this is a bunch of garbage, in my opinion, because they're just plain industrial robots. There is no other name for them. You can call them anything else and it ain't gonna work. In fact, our industrial psychologist told us that. But, they are also process oriented. They will do paint spraying, welding, wire laying, and routing. They are spot welding all of your automobiles together these days.

If we want to talk about benefits, here's what we're realizing: twenty to twenty-five percent productivity improvement. Robots don't go to the bathroom, they don't take coffee breaks, they just keep working. And if you want to talk about return on investment, that's excellent too. If you want to talk about what it can do for you in the OSHA area; it is kind of interesting that we had an OSHA citation the other day. The only comment they had was the robot was unloading the die cast machine and there was water between the robot and the machine. My suggestion was to give the robot a vacuum cleaner, a wet vacuum, and let it vacuum the water up. There was nobody in there anyway, so I don't know why we were worrying about it.

Typical applications: at Vern's Robot Farm, there's a Cincinnati robot that loads and unloads a lathe. In fact, a robot runs the lathe. It tells it when the door should open; a sensor says the door did open, it can come down inside, etc.

People tell me that robots can't keep up with humans. That's a bunch of garbage. If it is a properly engineered implementation of a robot, it can keep up with humans and work circles around them. If you find that the human was handling two parts simultaneously, that's what you have to do with a robot. It's a very efficient operation. In fact in one of our applications, the robot handles the job so efficiently that the robot got kind of bored and we had to have it change hands, let it pick up a welding gun, and do a TIG welding operation. In fact, a year ago I was told that this robot was not accurate enough to do TIG welding. My ignorance of some of these processes tells me to try it. After I did TIG welding, they came back and told me I couldn't do TIG welding that required more accuracy. By the way, we're the first in the United States to do TIG welding with a robot.

Some examples of what robots are doing are welding, paint spraying (if you buy a General Electric refrigerator these days it may have been sprayed by a robot, and we spray the welded seams of the liner on a moving converyor with a robot), and deburring operations. Some robots are known for their repeatability within 0.010 inch. That's a $75,000 robot and it may go to $150,000. They are not cheap, but they are very effective. One such robot is a Unimate robot in Toronto, Canada at International Harvester that loads and unloads a heat treating furnace. (There were some articles in recent magazines on that one.) Other Unimates load and unload plastic molding machines. If you buy a GE coffee maker these days, the plastic components for that coffee maker could have been unloaded from the plastic molding machine by robot with tender lovng care, by the way. Robots are being used to load and unload large presses. Here is an area in which we have a serious problem with OSHA. These presses make noise, there is no question about it. This is one way to solve the problem. You take the people out, put the robots in, and close the area to humans.

We have used a robot to operate a standard milling machine. All they've done is put a hydraulic clamping device on it. In fact the robot, even comes over (there's a film on this) and hits the speed lever to start it. This was in our labs last year.

We are holding our third annual seminar for GE people on May 31. The first year (1977) when we held that seminar, we had thirty-five attendees and four robots. Last year, we had eighty-seven attendees and eleven robots. This year, when I left the plant on Monday, we had one hundred people signed up and we have seventeen robots for this seminar, some of them coming in on consignment for the two days.

There is a robot with a GE solid-state camera in it. That camera is used to inspect the features of an automotive carburetor. The robot will accept or reject the carburetor and we could even have another robot put the good ones down one line and the others down another line.

Another robot loads a forging press--this baby is no dummy. It comes over and dips its hand in water every once in awhile to cool off. It's very flexible; you can make it do almost anything.

The Japanese are noted for their use of robots. In fact, last week I saw them using robots to track eddy current during a welding operation. We're taking a lot of interest in that because the robots that we're using for welding do not track the seam. We are going to use robots for welding in the General Electric Company, including welding one-of-a-kind parts. We have a very large welding program in my labs this year.

Now, how do you program these things? Well, this gentleman right here is programming a Tralfa robot. Tralfa robots are built in Norway by a wheelbarrow manufacturer to paint spray wheelbarrow bottoms on a conveyor. This robot happens to be accurate to 0.006 inch according to tests run by Lockheed. Once programmed, microprocessors store the program on floppy disks. This robot will store 64 different programs.

This gentlemam is using dependent control to program the Cincinnati robot. It will handle 300 pounds, has six axes of control, and is worth $66,000. It is the second smartest robot in the world right now.

Now, one thing that we learned very early in the game and we got very concerned over was whether hourly employees would accept this technology. We went out and hired an individual psychologist to give us managerial guidelines on how to implement this technology. Some questions like: Can workers be openly assured of [illegible]? The evaluation involved points put in the driver or restraining column, the totals are used to predict whether the approach will be sucessful. We also asked the industrial psychologist what to call this technology. He said there's one thing you'd better do and that is call it a robot because the hourly people think you are trying to pull the wool over their eyes if you call it anything else. So we call them robots and most everybody else is calling them robots these days.

We also came up with a "dumb mistakes" list as a part of the phychological report. The phychologist determined that it was not the hourly people that are surpressing this technology. (Believe me we didn't just explore within GE--we looked inside GE, outside GE, and places where they had robots that were both successful and failures.) He found out that the thing that was surpessing this technology was the conflict between manufacturing engineering and shop management. It was a shock at first, but then I began to realize how that could happen. Now we have added a second phase to our psycholocical impact study: the management aspect.

Very early in the game, I realized that there were some rules of thumb that were important (Production Automation Magazine will soon publish my list). One thing I don't think I have to explain is why I recommend putting them in a hostile environment. That's the easiest place to implement the robot and where we have been very successful.

Robots are truly productivity improvers. If you listen to our President at the General Electric Company, you will know that productivity is the number one priority. Twenty to twenty-five percent productivity improvement has been our experience.

In developing a plan to implement robotics, evaluate your long-term needs. Don't go in and start throwing them here and there and get one each of all the different brand names. What I mean by this is evaluate all of your robotic needs. For every vendor brand that you put in, you buy a tester, a recorder, and you buy spare parts. So if you have a number of brand names, you've got a lot of duplication of costs. Implementation costs are indirectly proportional to the cost of the robot. My definition of a robot is, it's a commerically available device that is reprogrammable and a few things like that. They produce everything from auto license plates which are very simple to the most sophisticated computer-controlled unit. When you put one of the simple devices in, it has a fixed extension, fixed attraction, fixed up, fixed down and fixed adjustable stops. The sequence is the only thing that varies. Sometimes it is a lot more expensive to install an inexspensive one than it would be to install one that costs $10,000 more.

When I go to evaluate applications of this technology for our operating components, they tell me, "Well you're from Corporate and you want to get into the complex stuff." I say, "I'm a Manufacturing guy, not too smart or I probably wouldn't have stayed in this field for so long." I want to start in the simple areas because I can't afford failures. Murphy's Law very much applies here. Assume that if it can happen, it will happen. One of our operating components came back to me about six times this year because the part wouldn't always come out of the die. What am I gonna do? I suggested getting an injector in there--there is no other solution. He came back, in fact keeps coming back asking the same questions, but he doesn't inplement the solution so I can't help him very much. Sensors is the namo of the game in this technology. As soon as you take the human out, you've lost a very sophisticated piece of equipment.

Don't expect your vendors to do it all for you either. "Turnkey" is a bad word. "Integrated turnkey" is what we are talking about these days. A sophisticated system requires you to be as responsible as your vendor.

Last, but not least, don't forget the people requirement. People say to me, "Well, how are you going to maintain them?" I say if you do a bad job up front, you will have problems. Our company

went out and hired an electronics technician because they saw electronic controls on the robot and they didn't understand them. What did they do about the aspects? They did absolutely nothing. They didn't even tell their mechanical maintenance personnel that they could adversely effect equipment accuracy on a permanent basis by improper maintenance. You've got to train personnal to maintain the robots properly.

Many questions that come up are on quality. The automotive companies say they have better quality then they ever had before. They don't have to put extra spot welds in because the robots are too dumb to realize that it's Monday morning and they didn't go out on the week-end, so they put in all the spot welds. It isn't necessary to overlap the material as much anymore so they save a lot of material. Robots don't get bored and the quality doesn't change--they are reliable. They are operational ninety-eight percent of the time and they're easy to maintain. If they weren't reliable, they wouldn't be hanging arouund in Ford Motor Company and there's 236 of them there and 150 in General Motors and 100 in Chrysler.

My conclusion with this technology is that the technology is mature. What is maturing is applications engineering. Our Vice President came through one day and asked why I was promoting the robot, they can't keep up with humans. I said I've got news for you. If it's a properly engineered implementation, they can work circles around humans. I pointed to the dual gripper hand and the fact that we pick a couple of parts up simultaneously to meet five second cycles, and I said that's what it's all about. The engineering of the implementation is important.

If you have any questions, I would be more than happy to answer them. Thank you.

APPLICATIONS IN CONFIGURATION MANAGEMENT

LT COLONEL WILLIAM G. FOHRMAN

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The presentation addresses a fundamental philosophical issue concerning Configuration Management. It deals with the need to upgrade the discipline to adequately perform the "technical and administrative surveillance role" and to place the "task" role of Configuration Management in proper prospective. The objective is to promote the management responsibilities of Configuration Management by establishing a proper charter within our basic directives, recruitment and training of technically oriented people and development of the management short fall.

BIOGRAPHY

Lt Colonel William G. Fohrman is currently Director of Configuration and Data Management for Aeronautical Systems Division, Wright-Patterson AFB, Ohio. He previously served as Director of Configuration Management for the Aeronautical Equipment Systems Program Office with prior assignmet as ASD Director of Support. While assigned to the Air Force Institute of Technology, he served one year with the Education With Industry program at Chemical Systems Division, United Technologies Corp., Sunnyvale, California.

Lt Colonel Fohrman has an extensive computer software background beginning as a computer programmer, systems analyst and chief of three technical Divisions while assigned to HQ Military Airlift Command. He is a graduate of the United States Naval Academy with an MPA from Golden Gate University, San Francisco, California.

POSITION PAPER

APPLICATIONS IN CONFIGURATION MANAGEMENT

The definition of configuration management as contained in AFR 65-3 relates to a management process. From that point forth, however, the regulation addresses configuration task elements of CM with relatively little emphasis on management. In the eyes of many and often in practice, configuration "management" equates to merely performing these task elements. By implication it reduces itself to a clerical function of participating in and recording events. There are many who are quite content to be configuration recorders and not configuration managers. If configuration recording is the true function, I submit that most configuration managers are grossly overpaid. There is much that is not done or done by someone else if a configuration "manager" limits himself to performing within the task confines of AFR 65-3.

I view configuration management involving three elements: Administrative, Clerical, and Technical management. As the clerical and administrative functions are well understood, I will limit the remaining remarks to technical management.

If one is to manage, he must have a resource to apply to affect a solution. That resource may be expertise, manpower or authority. Ideally it is all of these. An effective manager tends to influence the outcome of an event in a positive and productive manner. If one accepts this workaday definition, there are few configuration managers that truly manage. Part of the reason is that the management charter is not defined in AFM 65-3 and partly because of the preponderance of non-technically oriented people within CM.

Configuration Management grew from and is still essentially a subdiscipline of engineering. While engineering is responsible for item performance, CM is responsible for documenting that performance. The Configuration Manager's main interface throughout the development of a program is essentially with engineering or dealing with the products of engineering. In the ASD environment we have found that generally the technically oriented CM does a better job than a non-technical CM and specifically the CMs who are engineers tend to do the best job. The reason seems to be that there is no credibility gap when dealing engineer to engineer and that the depth of understanding the technical problem tends to be higher, hence stimulating questions/discussions which tend to lead to better CM performance. There are also many intangible benefits to be gained from this arrangement. While I do not advocate that every CM be an engineer, I do feel that CMs should have a good technical background and that these be supplemented with clerical or administrative skills or configuration assistants at appropriate grade levels.

With a base of technical CM personnel we could better address the technical management issue. While the Program Manager is ultimately responsible for all aspects of a program, in at least the ASD environment, he has tended to turn to engineering for all things technical including technical management. The result in many cases has been where engineering has done as much configuration (technical) management as they

have in ensuring item performance. Engineering generally writes the System Specification while all parties contribute to the Statement of Work. The project manager, particularly if assigned to numerous programs, may not have time nor necessarily be technically qualified to make a thorough review of the two documents to ensure that they are reflective of each other, that they are integrated from a management viewpoint and that they adequately communicate to the potential contractor the technical tasks to be done. Such technical management assessment from the CM together with the performance assessment from engineering could allow the project manager more time to devote his attention to total program considerations.

Configuration Management has impact at each milestone of a program. The scope of this involvement is not necessarily limited to the following paragraphs. The program event sequence is as specifically applied to small programs to simplify explanation. Large programs incorporate the same basic elements but the sequence of certain milestones may vary or be repeated.

Receipt of Form 56 (PMD)

- Pre-program strategy meeting
  - Scope of effort
  - Direction
  - CM Manpower availability
  - Estimated Manhour expenditure
  - Program milestone structure

System Specification (Tech Exhibit) - CM Coordination

- Is it manageable?
- Is it integrated with another project?
- Does it flow logically?
- Interfaces stated?
- Limited to statements about performance of the equipment?
- Ground rules for quality and testing included?
- Sufficient to drive the contractor part 1 spec?

Statement of Work (SOW) - CM Input and Coordination *Section J of contract if no SOW

- Is performance criteria reflective of CM?
- Is documentation addressed?
- Are schedules addressed?
- Is criteria stated that clearly convey to the contractor what constitutes successful completion of PDR, CDR, FCA, PCA, etc?

Configuration Mgmt. Plan/CRMP - Input to PMP. Statement of CM considerations.

- How to handle ECPs
- How to handle Interfaces
- Is construction consistent with AFR 800-3?

Purchase Request (PR) - CM Coordination

- Does PR include elements that satisfy CM requirements?

Pre RFP Data Review - Consolidate CM requirements

- Review strategy and input prior to release of RFP

Post RFP Review - Consolidate CM requirements
Assess reasonability of contractors submittal
Prioritize negotiating priorities
Review contractors preliminary CM plan

Precontract Negotiation
Clear statements of requirements
Clear milestone definitions
Establish functional baseline
ECP required for future functional baseline changes

Post Contract Review
Convey to contractor counterpart understanding of the contract.
Ensure contractor understands ECP requirement for changes to Sys. Spec.

Preliminary Design Review (PDR) *may require iteration
Approve Contractor CM Plan
Approve Contractor Drawing structure. (Contractor should have completed most of the conceptual drawings - guide at 80%).
Approve Development Specs. if in concert with Sys. Specs.
Establish allocated baseline.
ECP required for future development Spec. changes.

Critical Design Review (CDR)
Approve update of CM plan
Production drawings should be well along (guide at 80%).
Review draft of Product Spec. to track with Devel. spec.

Functional Audit - In most cases can incorporate the FQR.
Accomplished after Qual test and Qual test report in most cases.
Review documentation to ensure that devel spec, product draft, drawings and qual test report are consistent.

Physical Audit
Approve Product Spec.
Approve final drawings
Set product baseline
ECP required for future product baseline changes

PMRT - Participate as appropriate

Small programs are often rushed to contract due to financial considerations, give the illusion of simplicity and often have less experienced project managers. For any program, however, it places CM in a position to influence the conduct of the program in the critical early phases and to make a positive contribution to the management effort. It is normal practice for program management to turn to Engineering for performance support, to turn to the Controller for financial management support, to

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turn to Program Control and Procurement for their respective support. Configuration Management is in a position to contribute a great deal more than administrative and clerical functions. Let them turn to Configuration Managers for Configuration Management. AFR 65-3 should reflect this charter.

WILLIAM G. FOHRMAN, Lt Col, USAF
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Deputy for Acquisition Support
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4

AN INTEGRATED DATA BASE APPROACH TO CONFIGURATION MANAGEMENT AND TECHNICAL DOCUMENTATION CONTROL

BY

E. W. ANDERSON

MARTIN MARIETTA CORPORATION

SUMMARY

This paper covers the interrelationships of engineering design data (parts lists), technical documentation control and configuration management status and accounting, including change control, hardware incorporation verification and schedule data. It then shows how Martin Marietta's Technical Requirement Management System (TRMS) used those relationships in an integrated data base approach to data management.

INTRODUCTION - In today's environment of high technology systems and products there is a need to know, on a day-to-day basis, what the product is as it develops from concept to delivered item. In addition, there are contractural customer requirements to be met. Configuration management disciplines must be enforced to assure that those requirements are identified, recorded and controlled. The data, functions and information to be gathered, controlled and disseminated to management and customer, have certain relationships that can be used in an integrated data base to maximize processing efficiency, increase data integrity and provide the most useful management tools.

Martin Marietta's Technical Requirements Management System (TRMS) was developed using this integrated data base approach. The use of TRMS on a program results in increased productivity and lower costs through efficient project, engineering, configuration and data management.

BACKGROUND - A study was made to explore the feasibility of replacing existing planning, engineering and configuration management computer systems. These systems could be represented, as shown in Figure I, as separate programs processing their own files. The study concluded that 75 to 80% of the data in these separate files was redundant and that all the data was functionally related. Therefore, the decision was made to merge these separately treated functions of design engineering and configuration management into a single data base structured system.

SYSTEM DESCRIPTION - TRMS is divided into six functional independently operating systems:

- o Requirements Identification
- o Planning and Scheduling
- o Document Status
- o Parts Data
- o Configuration Verification
- o As Designed/As Built

While each function can operate independently, all data is stored in an integrated data base structure for access and use by any system. A graphic representation of this is shown in Figure II.

Figures I and II vividly depict the difference possible with an integrated data base approach to data management.

TYPES OF DATA - The data to be managed can be grouped into five basic categories:

- o Configuration Items
- o Documents
- o Parts
- o Tasks
- o Schedules

The information to be processed can be grouped into five basic categories:

- o Identification
- o Planning

- o Controlling
- o Statusing
- o Reporting

The functions to be performed require that the data to be stored and its related information be organized in a manner such that each function can be completely independent, yet have data easily usable by all functions. Therefore, a data base structure was established with an End Item (C.I.) Record, Drawing Record, Part Record and Task Record. Each root data record segment then carried its associated reference data with it. Where a data element appears more than once, it is the same element.

RELATIONSHIPS - Configurations or end items are controlled by a part number and serial number.

A part, assembly or subassembly is defined by a part number and/or revision level.

A drawing is controlled by a number and a revision level.

A change to a drawing is controlled by a task.

Planning defines schedule dates and change incorporation points.

Control is established by verification of data and interlocking related data as each design or build function is verified.

Based on the data in the data base, reports can then be prepared giving status and other information required for the program management.

FUNCTIONAL DESCRIPTIONS

REQUIREMENTS IDENTIFICATION - Identifies the design and/or build requirements. End items (or configuration items) are defined by number, drawing, part number, serial number and description. The C.I. can also be allocated to usage, build location, etc.

This information is then used to prepare design and build lists. The file is then also used as a reference for control of data in other functional areas. For example, a drawing or parts list cannot be released that is beyond the authorized scope entered into the requirements data file.

PLANNING AND SCHEDULING (Task Identification) - In order to plan and control design effort, as well as account for changes, each effort is assigned a task number for tracking and statusing.

The schedule statusing function defines the work to be accomplished, provides milestones/events to be tracked and authorizes engineering release activity.

DOCUMENT STATUS - This function defines the engineering drawing, contract specifications and any other program documents that require formal revision control. It shows revision levels and authorizing change authority. It performs the engineering release function to control all data in the data base.

PARTS DATA - Provides product definition. Individual drawing parts lists are entered into the data base. These lists then can be released as machine prepared integral parts lists or separate parts lists as required by contract.

By making use of the individual parts lists, as contained in the data base, complete product definitions that require indentured parts lists, alphanumeric parts lists, where used lists, etc., can all be prepared by the computer.

The parts data base also then can prepare the as designed list to be used for as designed/as built verification

CONFIGURATION VERIFICATION - Using data already entered into the data base, baseline configurations can be established. Changes can be scheduled and incorporation points planned to provide configuration status and accounting reports.

INTEGRATED DATA BASE - The integrated data base approach to performing the control and statusing functions required by engineering and configuration management and the elimination of data redundancy results in the following:

- o Greater Data Integrity
- o Broad Reporting Options
- o Simplified Data Manipulation
- o Minimized Repetitive Input
- o Substantial Labor Savings

The single data base and simplified processing of data makes it feasible to provide on-line access and processing for most of the information, making data available on a real-time basis to user, management and the customer.

SYSTEM USE - The complete capability of TRMS allows it to be used in all phases of a program from RFP to hardware delivery.

When an RFP is received, a schedule for proposal preparation and submittal can be entered and statused.

As hardware requirements are identified, they are entered into the data base. Advance parts lists, drawing trees, CFE, GFE lists, etc., can be prepared. These lists and associated data can be used as part of the proposal, as well as for backup data.

The data once entered is stored and used as required during following program phases and need not be reinput.

Product definition, from C.I. identifier to parts lists, drawing control and change identification, is entered into the system. Change incorporation verification is added to the system as it occurs.

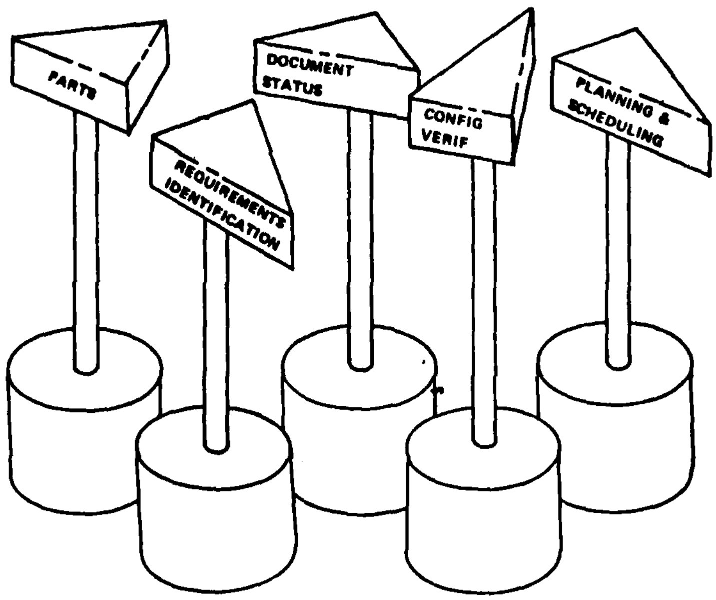
At product completion, reports are prepared that show C.I. configuration by as designed/as built lists with change accountability and verification for customer buy-off.

CONCLUSION - Since all functional data for design and build requirements, parts lists, change definition, schedule status and configuration verification are in a common on-line data base, accessible on a real-time basis, complete and up-to-date information is available during all phases of a program. Martin Marietta's TRMS is an up and operating system making use of this concept to provide its management with the tools needed for efficient program control.

TECHNICAL REQUIREMENTS MANAGEMENT CONTROL

AN INTEGRATED DATA BASE APPROACH TO CONFIGURATION MANAGEMENT AND TECHNICAL DOCUMENTATION CONTROL

MARTIN MARIETTA

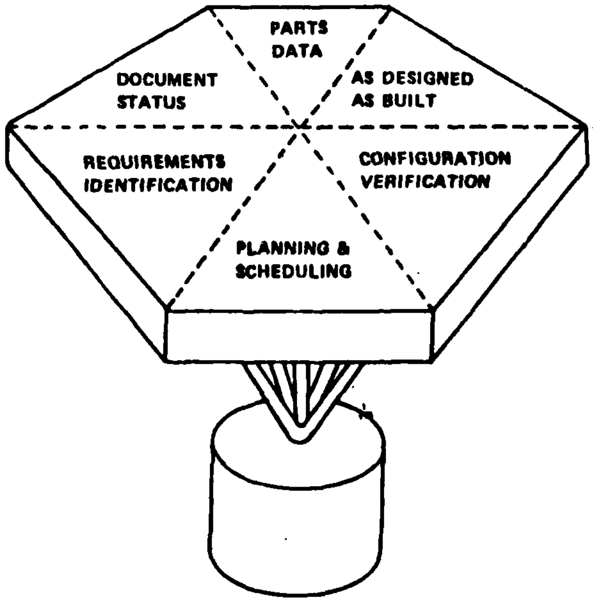


INDVIDUAL, SINGLE–FUNCTION SYSTEMS

Figure 1

FUNCTIONAL SYSTEMS

- REQUIREMENTS IDENTIFICATION
  - PLANNING AND SCHEDULING
    - DOCUMENT STATUS
      - PARTS DATA
        - CONFIGURATION VERIFICATION
          - AS DESIGNED/AS BUILT



SINGLE DATA BASE

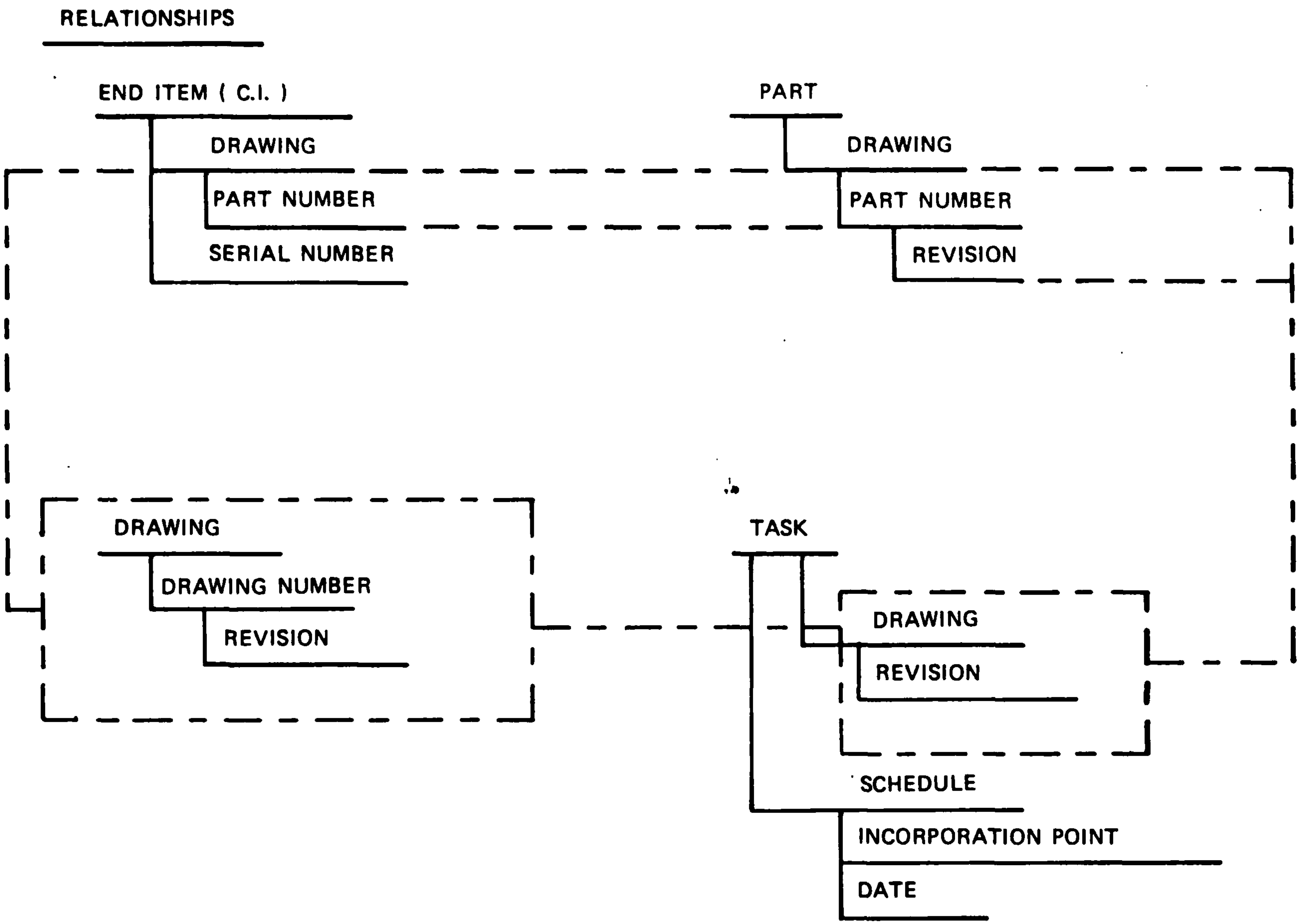
Figure 2

DATA CATEGORIES

- CONFIGURATION ITEMS
  - DOCUMENTS
    - PARTS
      - TASKS
        - SCHEDULES

INFORMATION

- IDENTIFICATION
- PLANNING
- CONTROLLING
- STATUSING
- REPORTING


RELATIONSHIPS
END ITEM (C.I.)
DRAWING
PART NUMBER
SERIAL NUMBER
PART
DRAWING
PART NUMBER
REVISION
DRAWING
DRAWING NUMBER
REVISION
TASK
DRAWING
REVISION
SCHEDULE
INCORPORATION POINT
DATE

ADVANTAGES

- GREATER DATA INTEGRITY
- BROADER REPORTING OPTIONS
- SIMPLEFIED DATA MANIPULATION
- MINIMIZED REPETITIVE INPUT
- SUBSTANTIAL LABOR SAVINGS

US ROLAND

TECHNOLOGY TRANSFER

AND

CONFIGURATION MANAGEMENT

US ROLAND
INTERNATIONAL INTERCHANGEABILITY

- BACKGROUND
  - INITIAL CONTRACT WITH HUGHES HAD NO REQUIREMENT FOR INTERNATIONAL INTERCHANGEABILITY
  - US–EUROPEAN JOINT EFFORTS INITIATED TO MINIMIZE SYSTEM DESIGN DIFFERENCES
  - CONTRACT MODIFIED TO REQUIRE US–EUROPEAN MISSILE INTERCHANGEABILITY
  - US–EUROPEANS AGREE TO CONSIDER AN EXPANDED LIST OF 558 ITEMS FOR I^2

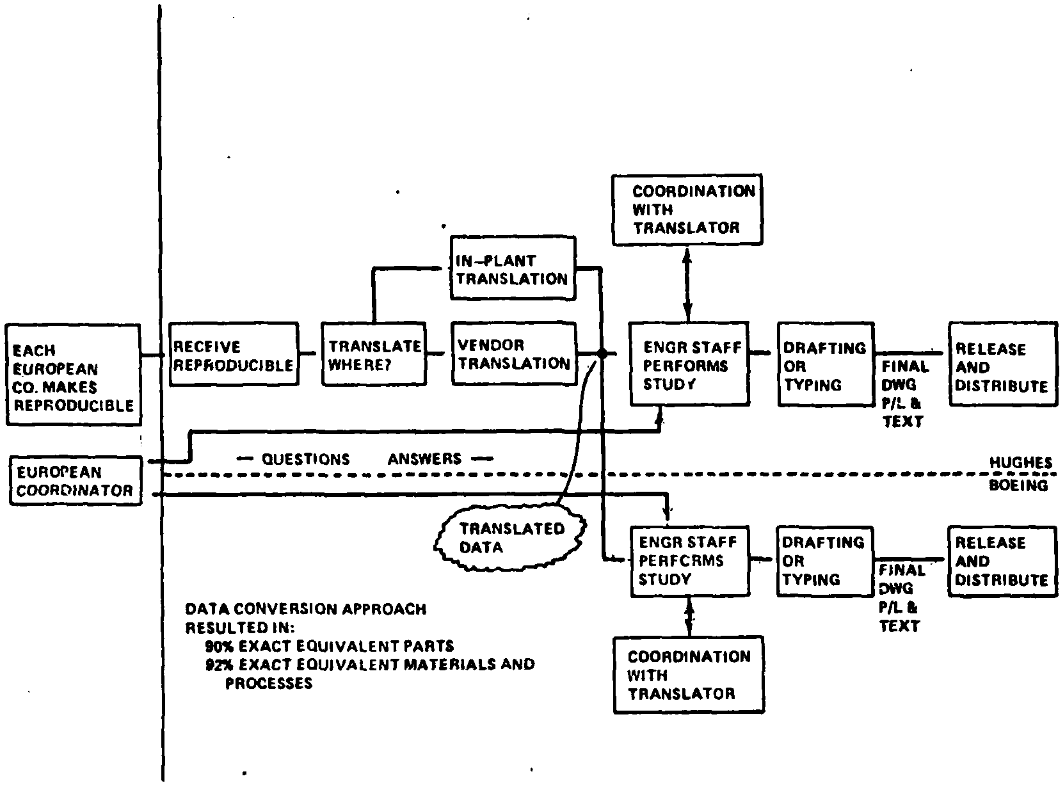
CONFIGURATION MANAGEMENT OBJECTIVES

MAXIMIZE INTERCHANGEABILITY

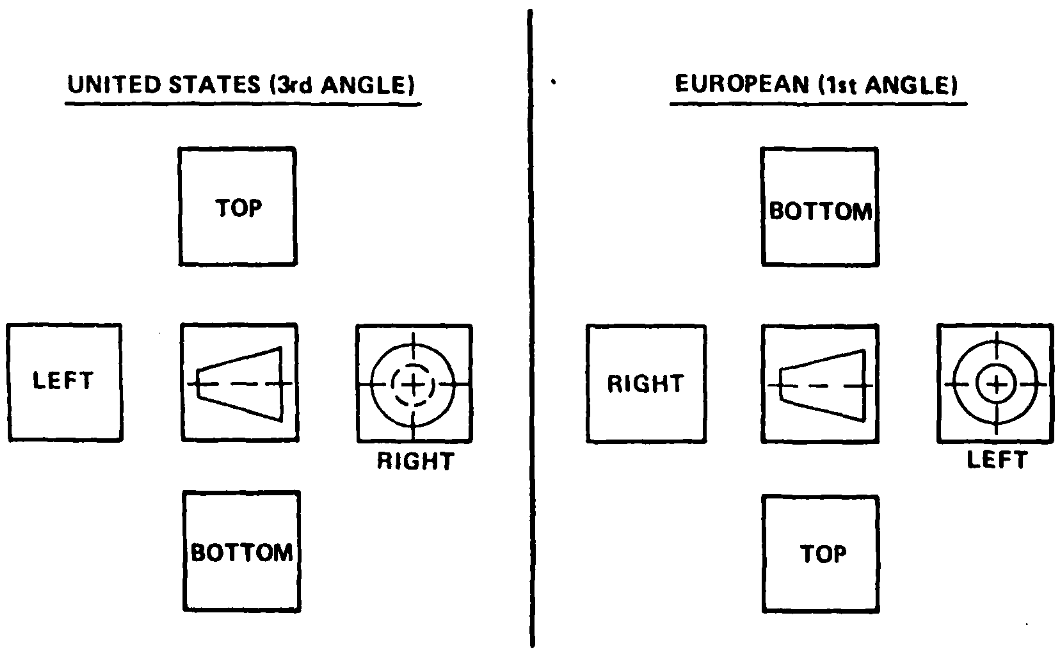
LATEST POSSIBLE EUROPEAN DESIGN IN TTF&T

MINIMIZE UNIQUE US CHANGES

ALL TTF&T HARDWARE IDENTICAL



DRAWING PROJECTION

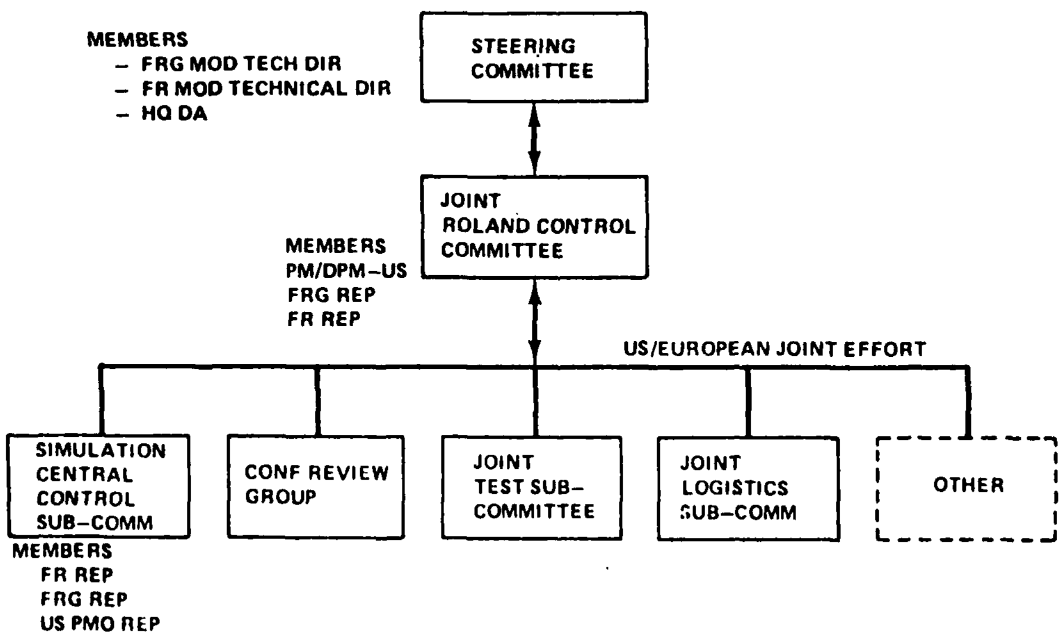


ROL–C

ROLAND POLICY ON METRICS

- METRIC DIMENSIONS TRANSFERRED DIRECTLY TO US DRAWINGS
- NEW DESIGNED ITEMS FOR SYSTEM TO BE IN METRICS
- NO DUAL DIMENSIONS ALLOWED ON DRAWINGS

US/EUROPEAN COORDINATION STRUCTURE



ROL-C

CONFIGURATION REVIEW GROUP (CRG)

- OBJECTIVE
  - TO ESTABLISH AN OPTIMUM LEVEL OF INTERCHANGEABILITY BETWEEN THE US AND EUROPEAN ROLAND SYSTEMS
  - PROVIDE MECHANISMS FOR MAINTAINING I^2 AT THIS LEVEL
- RESPONSIBILITY
  - IDENTIFY AND RESOLVE DIFFERENCES IN REQUIREMENTS AND MATERIEL DEFINITION
- FUNCTIONS
  - RESOLVE DIFFERENCES TO MAXIMUM EXTENT POSSIBLE BETWEEN SYSTEMS
  - REFER ACTIONS TO JRCC

US/EUROPEAN MEMORANDUM OF UNDERSTANDING (MOU) STATEMENT OF INTERCHANGEABILITY

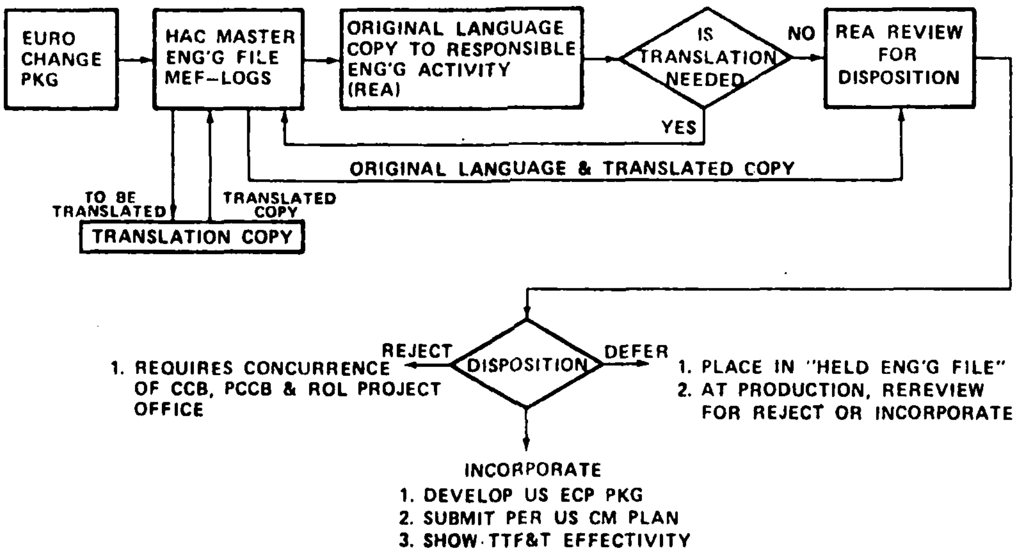
"THE PARTICIPATING COUNTRIES AGREE IN THE INTEREST OF INTERNATIONAL STANDARDIZATION OF MILITARY EQUIPMENT, TO MAINTAIN A DESIGN WHICH WILL PROMOTE INTERCHANGEABILITY OF SYSTEM COMPONENTS MANUFACTURED BY THE PARTICIPATING COUNTRIES. THE OBJECTIVE IS TO BE ACHIEVED BY KEEPING INTERCHANGEABILITY TO THE MAXIMUM EXTENT FEASIBLE CONSISTENT WITH NATIONAL PREROGATIVES."

DEFINITION OF INTERNATIONAL INTERCHANGEABILITY

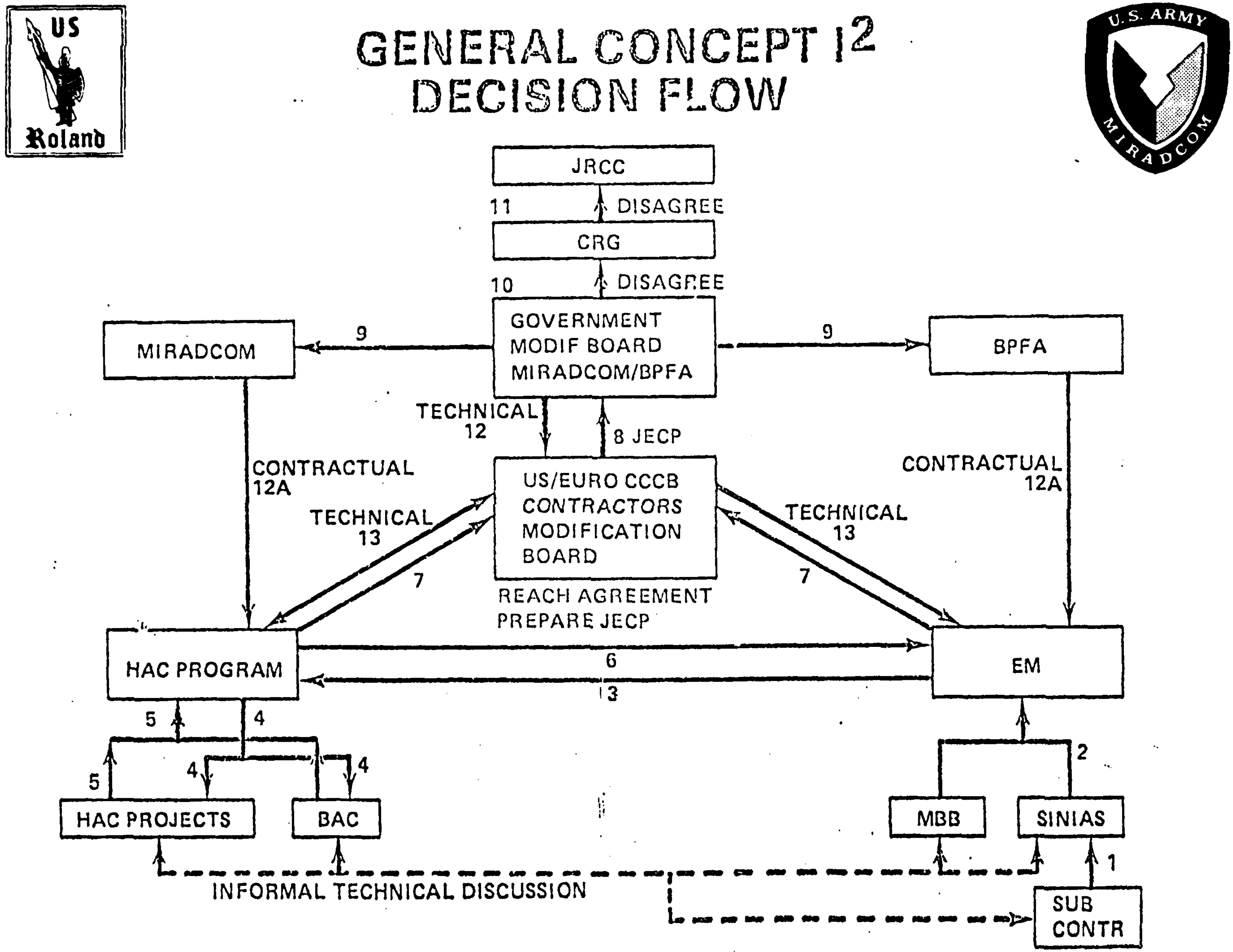
AN ITEM IS INTERNATIONALLY INTERCHANGEABLE IF IT IS EXCHANGEABLE IN FORM, FIT AND FUNCTION AND RETAINS THE SAME PERFORMANCE IT ORIGINALLY HAD. VARIATIONS IN SAFETY, RELIABILITY, MAINTAINABILITY, AND OTHER SIMILAR TRAITS MAY CHANGE, HOWEVER.

JOINTLY AGREED TO BY THE US, FRANCE, AND GERMANY

PROCESSING EUROPEAN ORIGINATED CHANGES IN US DURING TTF&T



GENERAL CONCEPT I²
DECISION FLOW

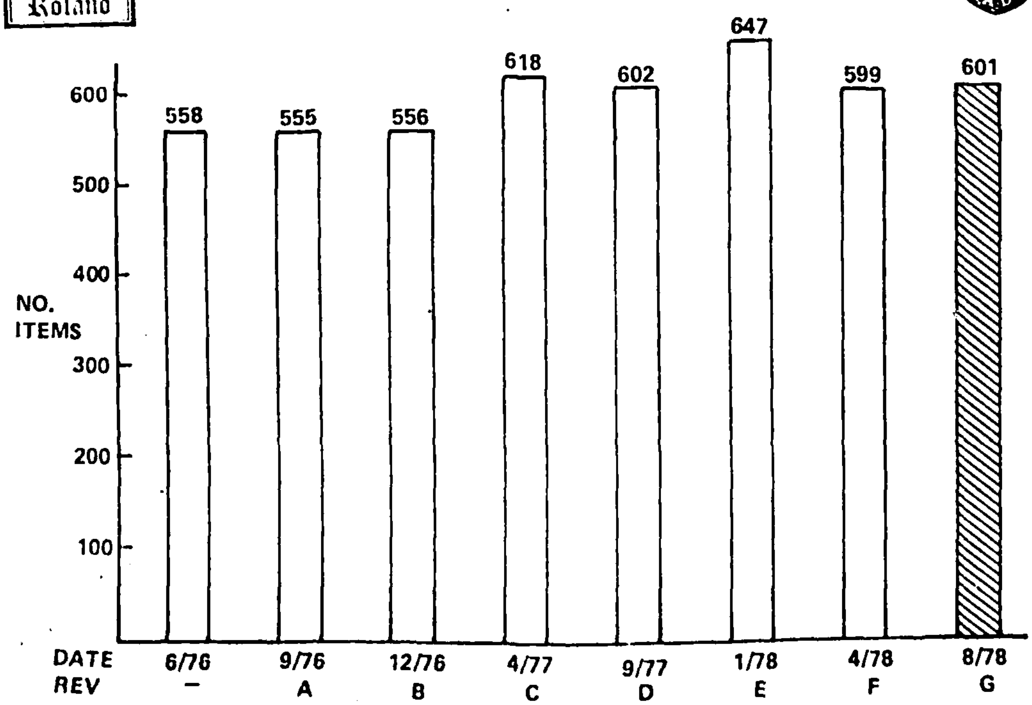


STATUS OF INTERNATIONAL INTERCHANGEABILITY (I^2) CANDIDATE LIST

The US ROLAND Program is now realizing maximum benefit of standardizing hardware with our European allies. For example, the ROLAND Missile is completely interchangeable between the three countries involved. This interchangeability will enable the French and Germans to fire a US missile from a European launcher and vise versa. To further illustrate the degree of system hardware interchangeability, approximately 96% of Field Replaceable Units (FRU) (slightly more than 600) in the transferred European ROLAND design (i.e., the total ROLAND System less European national items) are interchangeable..

US Roland

STATUS OF INTERNATIONAL INTERCHANGEABILITY (I^2) CANDIDATE LIST



US Roland

SUMMARY

- TECHNOLOGY TRANSFER SUCCESSFULLY COMPLETED
  - 25,000 DOCUMENTS COMPRISE "DEFINITION FILE"
  - 76,000 ADDITIONAL DOCUMENTS CONVERTED
  - 4.2 MILLION TECHNICAL DOCUMENT WORDS TRANSLATED
  - 90% EXACT EQUIVALENT PARTS
  - 92% EXACT EQUIVALENT MATERIALS AND PROCESSES
  - FIRST ANGLE PROJECTION AND METRIC DRAWING USE SUCCESSFULLY DEMONSTRATED
- CONTROL AND DISPOSITION OF EUROPEAN AND US CHANGES POSITIVELY ESTABLISHED
- VIABLE ORGANIZATION ESTABLISHED TO MAXIMIZE STANDARDIZATION AND INTERNATIONAL INTERCHANGEABILITY (I^2)
- OVER 600 CANDIDATE I^2 ITEMS
- DESIGN AND REQUIREMENT DIFFERENCES MINIMIZED
- PLANS ESTABLISHED BETWEEN US AND EUROPEAN PARTNERS FOR MAINTAINING MAXIMUM I^2

US Roland

LESSONS LEARNED

- OBTAIN ENOUGH DATA TO UNDERSTAND COMPLEXITY OF TECHNICAL DATA TRANSFER
- PROPOSALS SHOULD ADEQUATELY ADDRESS COST AND SCHEDULE TO COMPLETE TRANSFER
- SYSTEMS DESIGN STABILITY MUST BE ASSESSED
- ORGANIZATION MUST BE ESTABLISHED TO REQUIRE CLOSE COORDINATION WITH US AND FOREIGN CONTRACTOR AND GOVERNMENT ORGANIZATIONS
- PM MUST MAKE FREQUENT PERSONAL VISITS TO HIGH LEVEL US AND EUROPEAN GOVERNMENT AND CONTRACTOR PERSONNEL
- PROGRAM INTERFACES MUST BE ESTABLISHED EARLY TO ALLOW TECHNOLOGY TO BE TRANSFERRED IN ORDERLY MANNER

Vanishing Frontiers of Technology Boosts

Digitization of Engineering Data

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This paper briefly addresses the current state of computer-aided design technology and automated production techniques and points out some considerations and facts that would aid interested organizations in attaining solutions to the problem of storing, *manipulating and outputting* data usable by man and machine.

Attaining this goal will ultimately provide users with a universally-applicable digital system that will increase productivity and cost savings. It is for this reason additional organizations are encouraged to participate in breaking down the last few frontiers.

It is a pleasure for me to be here to talk to you about "how" vanishing frontiers of technology boost digitization of engineering data. Digitization as used here means conversion of information into a binary representation.

This is an area of vital concern to us at the Naval Ship Weapon Systems Engineering Station and to the Surface Warfare Fleet. Because of this, I want to take a few moments to review the beginning of the Naval Ship Weapon Systems Engineering Station, more commonly known as "NEMESIS", and to discuss its mission so as to set everybody's feet on the ground regarding the "Why" of our real interest in digitization of engineering data. The Engineering Station traces its origin to the closing days of World War II. Although U.S. Naval gunfire was fairly effective in warding off Japanese Kamikaze attacks, the attacks demonstrated clearly that a need existed for more effective weapon systems. Consequently, the Navy embarked on an accelerated program in the late 40's and early 50's to develop what became known as the Talos, Tartar and Terrier surface-to-air guided missiles. The development of these missiles - we call them the Three T's - created the additional requirement for a single Navy activity dedicated to the support of these complex systems. As a result of this need, the Naval Ship Missile Systems Engineering Station was activated as a tenant activity on the Seabee Base at Port Hueneme. The verbal acronym "NEMESIS" came into usage at that time. There were many reasons for selecting the construction battalion center as the host for our unique organization. The principal ones were the availability of a deep water port (the only one between Los Angeles and San Francisco), the proximity of the Pacific Missile Test Range, availability of existing facilities at the Seabee Center, and the bonus of a good labor market in the surrounding communities.

On 8 July 1963, the Station was commissioned with a cadre composed of 58 contractors, civilian employees and military personnel. Since then, the Station's tasks and personnel allowances

have continued to grow. This growth led, in 1972, to a name change. The Station initially was responsible for surface missile systems. Today it is involved with gun fire control systems, surface weapons switchboards, some search radars, underway replenishment and new systems such as AEGIS and HARPOON. Accordingly, the word "missile" was dropped in favor of "weapon". The verbal acronym - NEMESIS - remained the same, however.

Today our work force is composed of nearly 1700 civilian and about 75 military personnel. Our main thrust at the Station is in-service engineering. Simply stated, that means fleet support - make it work and keep it working. To accomplish this task, 38 percent of our work force is composed of professional engineers and another 17 percent of electronic and engineering technicians. Another 33 percent represents such professional disciplines as quality assurance, personnel and computer specialists, management and program analysts, logistics specialists, accountants, budget specialists and mathematicians.

When NEMESIS was organized in 1963, there were only 50 ships equipped with missile systems. Its mission then was to improve the performance of the Three T's. Now, in the late seventies, the Station provides engineering and logistics support to more than 200 surface combatant and auxiliary ships throughout the world. The command also provides support for 37 ships of nine friendly foreign nations. Our parent command, the Naval Sea Systems Command, further expanded our mission by designating NEMESIS as a Navy test and evaluation activity for surface weapon systems.

This growth in the number of ships supported and the types of support required has been accompanied by an increase in the technical data (parts lists, engineering drawings, specifications, design data, etc.) that the Station has to prepare, update, distribute, store, and maintain current.

The Station's technical data department provides the centralized location for the unique storage, updating, and retrieval capability of this data. The work effort is large and it is going to get larger.

These greatly expanded responsibilities, along with the growing technical complexity of surface systems, have made the task of technical data management and configuration management even more essential than it was in 1963 when the Station was commissioned. To meet the future requirements for accurate and timely technical data support, the Station must seek new and improved techniques to store, update and retrieve technical data.

During a typical year, we process 1200 engineering change proposals and 167 final Ordnance Alteration (ORDALT) texts. We review the data defining more than a quarter million hardware line items. The data repository that supports this activity is a three million aperture card library. Approximately 1/3 of a million aperture cards are entered into this file each year as new weapon systems are incorporated into the fleet and old systems are updated.

It is apparent to the technical data community at NEMESIS that new technology is moving into the area of automated production of engineering drawings. Throughout industry, company after company has "married" configuration and data management systems. A primary objective at NEMESIS is to capitalize on the industrial community's experience in fully automating the production, storage, retrieval and integration cycles of engineering drawings and related

lists and specifications and move forward to an era wherein all engineering data is digitized.

To assess this developing situation, NEMESIS sponsored master's theses of two Naval Postgraduate School students, Lieutenant Commander Billie Wieland and Lieutenant John Pounds, both now graduated. Professor Peter C. Wang coordinated their efforts here at Monterey. Under his guidance, the students had, as their specific objective, the development of a plan for upgrading the equipments and techniques at NEMESIS to meet the needs of the 1980's.

Among other things, these studies confirmed not only that industry is indeed converting to automated or semi-automated drafting and interactive design systems, but that industry was rapidly moving into the era of computer aided manufacturing. The day when the theories and practice of design and manufacturing would be tightly interlocked and interwoven appeared to be just a few years ahead. However, the utilization of digitized engineering data on a scale to support an active library of three million aperture cards seemed to be neither efficient or effective at the time this study was made. Major problems in the technology for storage, presentation and transmission of data mitigated against digitization.

Since that report, the driving force, industry's continued expansion of computer technology, has continued at an increasing rate.

Today there are digitally driven equipments such as color TV displays, high speed printers, and microfile devices that are used to assist designers in the development of a long list of products. Use of computers with these output devices present to designers as never before an opportunity to visualize design and check performance changes. General Motors Corp. has advertised on television and in weekly magazines the use of these techniques in developing their automotive products. However, they are far from being the only ones in this field. Designers use colored TV to view fabric patterns, color schemes, three-dimension projections of castings and machined parts, micro circuit layouts, logical designs, system flow networks for industrial plants, chemical production and traffic systems among many others. Today's designer uses the digits flowing through computers, transmission systems, and all types of display devices to implement their visualizations of design criteria needed to meet the production demands of industry.

After products are designed, other engineers again turn to the same sets of digital equipment to aid in the manufacture of products. Working with this technology, they develop programs to control a wide range of production equipment. The variety of these equipments and field of use expands daily. Digital control of weaving machinery is more than a century old. Numerically controlled machine tools have been around for several decades. Computer controlled wire wrapping has been used for more than a decade. Now we have laser beams under computer control cutting out patterns for clothing. To accommodate the demand for smaller and smaller circuitry, computers control laser beams and x-ray to form the latest in micro-circuitry. Today many companies have bridged the gap between computer aided design and computer aided manufacture to the extent that engineering drawings as we now know them are not needed. The driving force of automation is replacing the draftsman and his product, except where company and/or government contracts backed-up by regulations and standards require conventional drawings. Recently, I talked to an engineer from one of the nations more aggres-

sively innovative companies. They design, build and test parts without engineering drawings and then turn the completed parts over to a team of draftsmen so that regulations and standards can be met. The need exists now and is growing dramatically for new methods of storing, retrieving, transmitting and presenting engineering data.

Although the technology of several years ago seemed inadequate to support a general across the board digitization of engineering data, new products are closing the gap between the visionary schemes of yesterday and the realities of today.

In fact there have been across the board reductions in cost and size of the equipment coupled with increased speed of operation and computational power. Of course, this could have been expected as graphs of the period from 1965 to 1975 indicated this would happen.

Observing the available data, in 1959, there was one component per circuit while there were about 32 thousand components in 1975. Today there are equipments in use with more than 262 thousand components per circuit. Looking at the speed of switching units we find that in 1959 we had available some microsecond units while today the industry is building nanosecond switching units. Looking into costs we find that although the value of the dollar has been decreasing, the price of digital circuitry keeps decreasing. As an example, the cost of 1K bytes of computer memory was about $320.00 in 1973 and it costs as little as $32.00 today for a smaller and faster unit. In the field of mass memories, since 1970 we have been at a plateau of 6,250 bytes per inch for magnetic tapes used in the general trade. Now new technology will support a quantum jump to 65,000 bytes per inch of tape. Suddenly a tape library can be ten times smaller. But increasing density is not limited to magnetic tapes, disc memory density is also increasing. The latest releases indicate an increase from 29 million bytes per disc pack in the 1969 era to 635 million bytes of data per pack in 1979. Then in the area of mass storage, the latest releases claim a maximum acquisition time of 5-1/2 seconds with a total storage capacity of 152 billion bytes. This equipment does not yet use the latest in high density tape storage, therefore even this system is subject to further expansion within the bounds of known technology. Several other mass storage devices are coming on-line. One is Bubble memory technology. This is a relatively new technology but one already finding a secure niche in the communications industry. Even here, new technology already tested will allow 4 million bits to be stored in a 1-CM^2 chip. At the same time, the new techniques will permit a speed increase of not less than 10 times the speed of presently available units. And further, experts in this field expect equally significant product improvements in the near future. The other technology that has arrived is video disc. This is not a new field, but what has happened is significant. Video discs are being built for the home entertainment market. The costs for encoding and decoding technology has been reduced by a magnitude when compared with test units of just four years ago.

In the field of conversion of graphics to digits, the most significant forward steps have been made in the field of scanning. Solid state devices such as the Linear Array Charged Coupled Scanning elements immediately convert an image directly into digital signals. These devices have greatly simplified conversion techniques while reducing costs. But more conventional scanning techniques have also shown dramatic speed increases with overall cutting of operational costs. Parallel

with development of better scanning devices, the video display field is expanding rapidly. 105 megahertz bandwidths for a Cathode Ray Tube is becoming commonplace. In another Cathode Ray Tube area, one manufacturer offers a desk top computer with high density 19" storage display. This unit has excellent capabilities to present engineering data to a user who desires to scan, and possibly update it.

One last area where improvements impact digitization of engineering data is communications. Costs for receive sites for satellite communications have come down significantly. Today a receive only site can be installed for as little as $25,000.00. This is but a small item of the total picture. However, indicative of the tremendous acceleration in the field of communications, AM International will offer to industry in 1981 a facsimile system able to transmit one page every second. The system will require a 1-1/2 megahertz bandwidth. This technology can be readily used to transmit engineering data. Since engineering data is a valuable form of information, it is apparent that this technology will be used to transmit technical data.

A review of technology available now and four years ago confirms that graphical charts showing decreasing costs and increasing capabilities for digital equipments in the future are still on track.

The question that must be faced today is this: "Has the driving force of industry use of CAD/CAM brought the data world to the point where digital storage, retrieval and transmission of engineering data will be implemented?" Some companies and a few government agencies believe that it has.

I will mention three activities. The first is PRC Image Data Systems of McLean, Virginia. Dr. Gerad Walter of their company has written several articles about this subject and has proposed what he calls the Total Information Environment. The second, Defense Logistics Services Center of Battle Creek, Michigan, is installing a system for digitization, storage and retrieval of engineering data. And the third is the U.S. Army Research and Development Command at the Aberdeen Proving Ground, Maryland. At that activity they are installing a system that will digitize, store and retrieve engineering data.

As never before there is an international race for technical supremacy, it may be even a race for survival of the world as a dynamic entity. At this juncture of events, we are approaching the era of total digitization of the medias of information, speech, printed material, and graphics. The driving force of change is going to impact the field of engineering data. Moveable type revolutionized printing and brought about a great diffusion of knowledge throughout civilization. Today the simplest of information forms, the binary element, as used in manufacturing, communications and problem solving, is producing another revolution of information flow unparalleled in all history. The frontiers of digital technology as outlined above are being pushed back at a tremendous pace.

Every data manager will soon have to prepare for the coming of digitization. Let us trust that none of us will be "a day late and a dollar short" in meeting the coming age of a total Digital Information Environment.

SESSION 4

Workshop Coordinator

MRS. LORNA BURNS
Hughes Aircraft Company

June 4, 1979

ADPA Technical Documentation Division
Data Management Section Workshop

Workshop Chairman introduced Mr. Vince Mayolo, DMSSO, and Mr. Harvey Cook, Northrop, as a select panel with Mr. Bud McCarty as Recorder, to focus comments and replies to topics/questions identified by workshop participants. Included in the group were twenty-two (22) from Government organizations, twenty-one (21) from Industry, and one (1) unattached. Fourteen (14) questions (many multi-part) were submitted by eleven (11) participants, and are summarized below.

Question 1 - Are there definitions that provide enough information to delineate the difference between data management and configuration management?

Response 1 - Some reported combination of these functions in one organization; some feel this combination tends to weaken each function; some feel that Data Management is essentially the configuration management of data. It was agreed that there is widespread misunderstanding of what the data management discipline actually is (or should be) both in Government and Industry.

Question 2 - What is the status of DOD 5000.32M? What were the main Government comments? What were the main Industry comments? What are the future plans for this document?

Response 2 - provided by Mr. Mayolo - For all practical purposes, this document is dead; although the philosophy/policy contained therein is very much alive. Comments from the three-services were good, with those from two services constructive - the third service essentially wanted no change in status quo. Although Mr. Golmis's report had mentioned substantial ADPA coordination on this draft document, no official ADPA comments were received. The CODSIA comments were reviewed briefly by Mr. Mayolo, who also noted some concern in apparent CODSIA review procedures. It was indicated that the essentials of DOD5000.32M would probably be coming out under another number.

Questions 3, 4, 5 - Several questions on data pricing: Are there any established methods for cost estimating data? How is estimating done by other contractors? Contractor price grouping of data items is a dilemma. Examples provided by DD1423 etc. are not clear. Could the Government suggest price groups for concurrence by the contractor? To satisfy the Government need for reliable data costs, can contractors break out data preparation costs or preparation plus engineering effort?

Responses 3, 4, 5 - The CDRL form is an unsatisfactory guide for data pricing. A more thorough treatise is contained in ASPM #1. Many feel that emphasis should be on the element of delta cost - and that delta costs are seldom identified to enable the Government to make a cost-benefit decision. It became evident that the matter of definition of "data" is essential for this problem to be properly faced and that this topic should be dealt with in any effort defining the data management function.

Question 6 - Is there a spec or std covering data and CDRL items similar to MIL-STD-100 for drawing practices?

Response 6 - Not specifically although the AMSDL does provide some assistance. This discussion triggered a major discussion on the circumstances surrounding the lack of a data management standard.

Question 7, 8 - Is the generation of a DM std being seriously discussed? What happened to the draft std on Data Mgt.?

Response 7, 8 - A couple of very preliminary drafts were circulated last year with essentially two responses: (a) violent disagreement with the concept by many in industry (not associated in the day-to-day DM function) and an official letter from AIA to the workshop chairman and (b) positive comments. There is no current effort being expended on this. After much discussion it was the consensus that a sub-committee should continue work in this area.

Question 9 - ASPR requires the inclusion of DD Form 1660, Mgt. System List, in contracts. Is there any practical value to this? Does this inpact the contractor in any way? Should the form be rescinded?

Response 9 - It is dead but not buried. It serves no current useful purpose. Recommended that ADPA recommend it's elimination.

Question 10 - Why is the DID system necessary (paraphrase)?

Response 10 - History of events bringing about creation of DOD Data Mgt System was related.

Question 11 - What can be done to reduce/eliminate the costly practice of delivering data via DD Form 250?

Response 11 - A subcommittee has been established to assemble adequate information to form the basis for an ADPA letter to the FAR(DAR) Committee.

Question 12 - Discuss DD Form 708. Why use for data in lieu of DD 1423?

Response 12 - Developed by AFSC to computerize contract. There is an existing FAR deviation permitting its use. It's inflexibility with regard to use of the DD 250 is major problem.

Question 13 - Is there a standard DM plan for responding to RFP's - each RFP seems to require different responses to how data is managed.

Response 13 - There is no standard response or plan. Question adds emphasis to the confusion surrounding the DM function.

Question 14 - What is the real definition of a Data Manager and associated career field? What is the future?

Response 14 - The answer to this question is wrapped up in the total definition of the Data Management function which needs to be addressed.

Action items to be handled by Section Subcommittee effort this coming year:

1. Establishment of a consensus definition of the Data Management function.

2. Investigate feasibility and advisability of generating a DM standard and the resulting recommended action(s) which would be appropriate.

3. Initiate letter to FAR(DAR) committee recommending deletion of DD Form 1660.

4. Initiate letter to FAR(DAR) recommending major reduction in use of DD Form 250 for delivery of data.

5. Investigate feasibility of use of consensus DID's for techinical manual DID's.

6. Provide analysis of current trends and recommendations for general actions to be taken to manage non-traditional data (CAD/CAM; digitized; electronic transfer, etc.).

* Generated at pre-workshop meeting 5/22/79.

John Hart

John R. Hart
Chairman
Data Management Section

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AGENDA

Workshop #2

Configuration Management

Thursday, May 24, 1979 - 1315 Hours

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PANEL MEMBERS: Mr. T. W. Cozine
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SUBJECTS:

1. MIL-STD-480/DoD-STD-480A
   Configuration Control-Engineering Changes, Deviations, and Waivers
2. DoD-STD-480A, Appendix F
   Guidance for the Tailoring of DoD-STD-480A to Specific Program Requirements
3. Questions and/or Problems Posed by the Workshop Attendees
4. Development of an Action Item List for Unanswered/Unresolved Items to be Worked on During the Coming Year

PURPOSE

The purpose of this Configuration Management Workshop is to utilize the knowledge gained by the government and industry participants who work with and apply this management discipline on a day-to-day basis and also improve communications regarding CM matters between all of the attendees here this afternoon. The objective of this workshop is to identify and resolve problems which are currently being experienced by the attendees through questions and answers posed by both the panel and the attendees. Those problems which require specification changes to resolve, or are otherwise too time-consuming or complex to resolve here this afternoon, will be recorded as action items and will be addressed by the CM committee during the coming year. Those of you who wish to participate as an active member of that committee, please indicate by placing a "YES" next to your name on the Attendance Roster.

If you have a question which you wish to address to the panel, or a statement which you wish to make to this workshop, please raise your hand. When you are recognized by the Chair, please state your name, organizational affiliation, and job title. Also, please limit your initial statement or question, if possible, to five minutes. Again, we would like to encourage <u>your</u> participation in this workshop so that we <u>all</u>, as a whole, might benefit.

Configuration Management

Workshop Number 2

SUMMARY

1. Mr. Ted Cozine provided the members of the workshop with an overview of some of the differences between MIL-STD-480 and DoD-STD-480A. The chairman then opened the workshop for comments concerning DoD-STD-480A. The majority of the comments received by the panel were addressed to paragraph 4.1, the last two sentences of which, read as follows:

> "The contractor shall provide the procuring activity with a copy of the initial parts substitution list and all changes as they occur. An annotated parts list may be used in lieu of a separate parts substitution list as mutually agreed between the contractor and the procuring activity."

Specific comments were:

- This is a cost driver as it requires <u>us</u> to make separate listings for those parts where we have substituted.
- Requiring an annotated parts list mutually agreed to by the government and the contractor is very expensive.
- The substituted part number must be entered on numerous drawings and logistic support data, which involves time and money.

It was suggested by a member of the workshop that the government prepare a list of those parts and materials which might be used for substitution. It was generally agreed that this was an impossible task due to the large number of government custodians involved in the preparation and maintenance

of Mil Specs. It was then proposed that the last two sentences of paragraph 4.1 be deleted. Mr. T. Golmis requested that this subject be addressed as an action item, to be followed up by members of the panel.

2. Mr. Bill Dean provided the attendees with a narrative on Appendix F to MIL-STD-480A, which is entitled "Guidance for the Tailoring of DoD-STD-480A to Specific Program Requirements." Even though Appendix F was released by the government on 29 December 1978, it should be noted that most of the workshop members had not received a copy. Mr. Cozine indicated that action was being taken to alleviate this problem. Mr. Dean then explained that this appendix is unique in that it "serves as a <u>guide</u> for the activity responsible for the preparation of contract requirements and, as such, shall <u>not</u> in itself form a part of the contract."

3. The following previously prepared statements and questions from the members of the workshop were addressed by the panel:

<u>QUESTION</u>: What is the timetable for the release of MIL-STD-XXX?

<u>ANSWER</u>: The current DoD CM Standardization Program Plan calls for a release by the fourth quarter of CY 1980.

<u>QUESTION</u>: Has there been a DID prepared for invoking 480A on contracts?

<u>ANSWER</u>: 480A is itself invoked on the contract and associated DIDs are then entered on the CDRL for ECPs, deviations, waivers, etc.

<u>QUESTION</u>: Are there definitions that provide enough information to delineate the difference between Data Management and CM?

<u>ANSWER</u>: DM is the management of data and the costs associated with the preparation and delivery of data. CM is a management discipline which encompasses <u>both</u> hardware and all of its associated data.

<u>QUESTION</u>: AFSC/ESD requires that section 2 of specifications call for the specific issue of referenced documents by revision letter, notice number, and date. Why is the date necessary?

ANSWER: It is required by ASPR.

QUESTION: How is the Military and Industry handling the abbreviation of long Mil Spec numbers on drawings and associated lists, computerized lists, and Bills of Material? There is a problem when the computer part number field has limitations.

ANSWER: Many companies are maintaining separate listings of internal numbers to maintain those spec numbers which exceed the computer field.

QUESTION: MIL-STD-480 and DoD-STD-480A specify criteria for classification (Class I) of engineering changes. These, at best, are ambiguous and hard to interpret; 480B must require tailoring of criteria to each program and change the specified criteria to guidelines. One set of criteria never can apply to many different programs.

ANSWER: This subject was discussed by the attendees and panel members. It was not, however, fully explored and it was not part of the agenda for this workshop.

ACTION ITEMS

MIL-STD-480A, paragraph 4.1, will be addressed by the panel and a proposed resolution drafted.

CONTINUING ACTION ITEMS

Mr. C. Embrey will provide workshop members with updated joint DoD CM Standardization Program Plans and drafts of CM documents for comment, as they become available.

Configuration Management

Workshop Number 2

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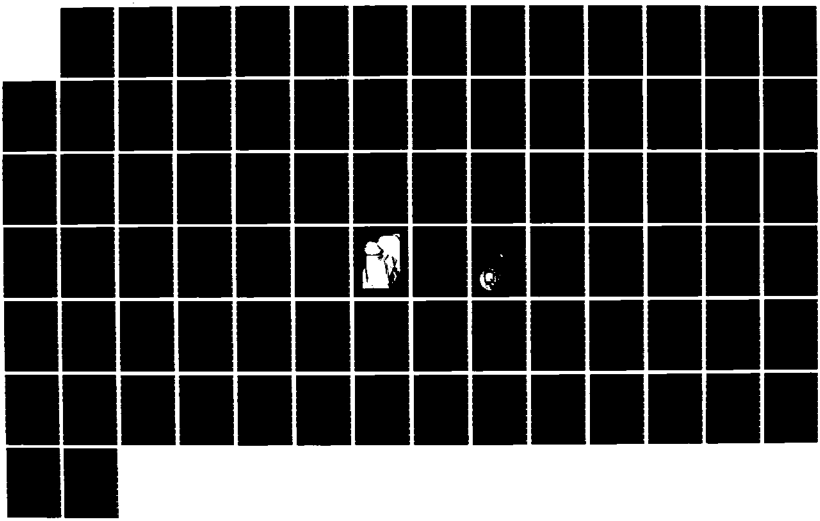

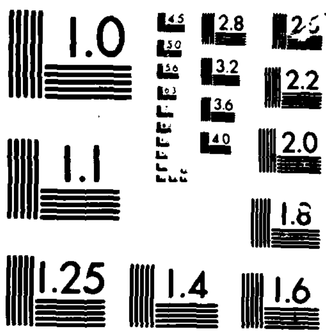
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WORKSHOP #3 - ENGINEERING DRAWINGS

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Raytheon Corp.

Maurice Taylor
U.S. Army

ASSISTED BY: Charles Fricke
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WORKSHOP #3 - ENGINEERING DRAWINGS

ATTENDEES

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WORKSHOP #3 - ENGINEERING DRAWINGS (CONTINUED)

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WORKSHOP #3 - ENGINEERING DRAWINGS

1. Q. Why are dates specified for industry standards in the applicable specification section of a government standard or specification but not specified for applicable military standards or specifications?

   A. The government does not control when industry revises their documents. Only those industry standards and specifications which the government has approved are usable in contracts. Each specific issue must be approved. The issues are controlled by the document date.

2. Q. Why are there two non-government documents covering the same subject listed in DOD-STD-100C? Example: IEEE-STD-315-1975 and ANSI-Y32.2-1975.

   A. In the past, when a document was submitted to ANSI for approval, it was assigned an ANSI peculiar number. Presently, ANSI has discontinued assigning new numbers and instead prefixes the subcommittee number. There will be a transition period until a document with two numbers is revised; at that time the numbers will be replaced with a single identifier.

3. Q. What is the meaning of "certification" as referenced in Para. 504.1.3 of MIL-STD-100B?

   A. Certification refers to the signature of a qualified person who verifies that the change was accurately and completely incorporated into the document.

4. Q. Re-identification "up to and including the assembly where interchangeability is re-established" as required in Para. 1-302.14-3, Item C, was "proven" unworkable and changed in Rev. B. Why was it changed back in Rev. C?

   A. Industry outcry over the change in Rev. B brought about the change in Rev. C to what it was prior to Rev. B. Opponents far outnumbered the proponents. To them it was never unworkable.

5. Q. Have slash sheets to DOD-D-1000 been cancelled, and, if not, will they be?

   A. Not yet. AFAD 71-700 is slated to be cancelled on June 1, 1979, and a cancellation notice for the others will be issued.

6. Q. If no tailoring is specified in a contract, how should a contractor interpret DOD-D-1000?

A. If you sign a contract for drawings in accordance with DOD-D-1000 without the procurement document completed in accordance with Para. 6.2, you have bought it all. In other words, don't sign.

7. Q. DOD-STD-100C says that the letters "S" and "Z" and others shall not be used. (Re Para. 402.5.a.) Do I have to change present practices and/or change revisions?

A. Para. 402.5.a allows for the continued use of letters "S" and "Z" if they are part of an existing drawing numbering system.

8. Q. Is it all right for a company to make control drawings of MS parts and charge overhead on a military contract? If not, how can it be stopped?

A. Para. 3.6 of DOD-D-1000B states that engineering drawings shall not be prepared or submitted for items that are defined by government specifications, standards, or nationally recognized industry association specifications or standards.

On the other hand, because of company practices, Para. 402.11.2 of DOD-STD-100C allows the following parenthetical identifier. "Using design activity identifying numbers may be referenced parenthetically to identify in-house peculiar identities."

Interpreting the two statements above, if for peculiar in-house requirements it is necessary to prepare drawings or have in-house identifiers for MS parts, the in-house number is a reference number and would be shown parenthetically with the MS number, which is the prime callout on the drawing or list. It is the intent of the standards not to create redundant data.

9. Q. Please discuss the conversion of design development drawings to production phase drawings and any special problems involved.

A. Amendment 1 to DOD-D-1000B, "Guide for Application and Tailoring of the Specification," has as its prime purpose the clarification of the differences in the various phases of a program.

The differences between a drawing package for a development program and a production program are the types and quantities of drawings needed to build the hardware for the particular contract. Such factors as: (1) quantity of items to be built, (2) where the articles are to be built in your facility (model ship or production floor), (3) engineering build vs. full manufacturing controls, etc., determine what types of drawings are necessary. (See Para. 30.3.1 of Amendment 1 to DOD-D-1000.)

9. A. (Continued)

Levels are not to be interpreted as three levels of drawing quality (good, better, best) that a drafting department can create on their own from a drafting manual. When someone orders a Level 3 production drawing package during initial development phase, this is an indication of lack of understanding and a misconception of the standards on their part.

Hardware manufacture relates to phases of a program; i.e., conceptual, development, limited production, production, etc. Phases of a program relate to levels. Levels relate to the standards and drawing practices. Para. 3.4.3 of DOD-D-1000 states, "Unless otherwise specified in the contract or order (see 6.2.1), the contractor is responsible for the selection and number of engineering drawings necessary to satisfy the content and requirements of the level(s) ordered."

10. Q. How do you call out items in parts lists and drawings that are covered by federal specifications where no part or identifying numbers are provided?

A. A description is used (e.g. 3/9 inch box wrench per QQ-X-XXX). See question 11 for additional information.

11. Q. How can part numbers be handled where no part number is available and a description must be used; or part numbers that exceed 15 digits; or same number but are inadvertently written differently, such as omission or insertion of a space, slash, period, etc.? What provisions are being made to accommodate computer printed lists?

A. Many companies make cross reference type drawings which assign a DOD-STD-100 compliant number to items with descriptive identifiers or identifiers exceeding 15 digits. (It was reported that the ANSI Y14.24 Committee on Types of Drawings is contemplating an "Identification Control Drawing" to handle that problem.)

In relation to the other question of omissions, insertions, slashes, etc., most companies have similar problems. It requires training of drafting personnel and personnel inputting to the computers.

12. Q. Do logic diagrams have to be made and submitted to meet DOD-D-1000 requirements even though they are not required by internal plant operation for digital PCB's? Can computer generated "engineering lists" and logic "implementation lists" be considered a suitable substitute?

A. Although the type of data to support a particular line item of the contract is the responsibility of the contractor according to DOD-D-1000, Para. 3.4.3, it still must meet the requirements to satisfy the total function the particular hardware is to be used. This may include data to support interface control, logistic support, maintenance, government manufacture, etc. The agreement on the data package contents should be reviewed in that light with customer concurrence on any doubtful areas.

12 A. (Continued)

It was the opinion of the panel that it would be unlikely that data to support digital PCB's would be complete without logic diagrams to support design evaluation, future engineering changes, manuals, etc., unless the program is so peculiar that only data to support manufacture is required with no additional objectives.

13. Q. MIL-STD-275 Master Drawings - Should the hole count include test coupons?

A. The hole count should state if it includes the test coupon holes or not.

14. Q. MIL-STD-275 - Is there a preferred format for showing manufacturing allowances?

A. No. It is our understanding that IPC is considering one.

15. Q. What is a non-drawing copy? Non-drawing copies are called out in MIL-D-5480.

A. This question was referred to John Sutton, Chairman of the ADPA/TDD Micro-Reporduction Section. John's investigation produced the following. A non-drawing copy is a copy made from documents, such as parts lists, wire lists, bookform drawings, specifications, etc. It appears that any document including certain types of drawings as specified in DOD-STD-100, which are text and not dimensional items, fall under the present definition. John reported that the preparing activity of MIL-D-5480 recognizes the problem with the clarity of the term and will take future action to rectify the problem.

16. Q. What are companies doing to reduce the release of duplicate parts and to control usage of military part numbers?

A. Many companies develop parts selection documents which contain company, industry, and military standards. They require their design personnel to select parts for new designs from the parts selection document which will then control the usage and release. Further some automated parts listings systems are in use which restrict the output to those items which are contained in a master file. Entries to this master file are tightly controlled to prevent entry of unauthorized items.

16 A. (Continued)

There were numerous questions that referred to Specification or Source Control Drawings.

It was decided by the panel, with no objections from the workshop attendees, that those questions should not take up any time because of the current work in process.

The Engineering Drawing Requirements Section of ADPA/TDD, at the request of the Department of Defense, has undertaken the task of reviewing the present definitions and requirements of Specification Source Control Drawings in the DOD-STD-100. There is an 18 member special committee already functioning. The committee will coordinate its findings and recommendations with the ANSI Y14.24 Committee on Types of Drawings.

NOTE: For those who did not obtain copies, the Summary of Changes Incorporated into DOD-STD-100C distributed at the workshop are included in section Y of these proceedings.

ACTION ITEMS FOR THE ADPA DRAWING REQUIREMENTS SECTION

1. DOD-STD-100C, Para. 107 presently calls out a requirement for a caution note when the drawings are for items using radioactive materials. Is the note too restrictive by referring only to radioactive materials when there are other materials that could also be categorized as hazardous?

2. There is nothing presently called out in DOD-STD-100 referring to or defining "firmware."

3. The present DOD-STD-100C does not cover how to define alternate parts (not substitute) on drawings or parts lists.

4. Some elements of the Air Force and Navy through DID's, AFAD's etc., require an application block (or referenced list) on all assembly drawings. The block requires next assemblies and quantities. With the high initial expense and recurring update cost, why do they have this requirement.

5. Para. 502.3 of DOD-STD-100C requires that when a drawing is revised, the latest applicable approved standard shall be used. The requirement is mandatory, which could cause problems.

6. Assist in the preparation of a specification or standard for handling computer graphics. Present drawing documents do not adequately address this growing problem.

7. An action item for the Micro-Reproduction Section arose in this workshop and was passed on to John Sutton, Chairman of that ADPA/TDD Section. Certain contractors are meeting the requirements of MIL-M-9868 of fifth generation quality by using super sharp cameras whose capability exceeds that of standard microfilm equipment. It was suggested that the specification MIL-M-9868 be reviewed for possible change to identify use of standard rather than special equipment.

8. An action item arose as a result of a discussion about the addition of nameplates by a using activity on end items of another design activity. The addition of the nameplate requires the preparation of either another higher level assembly drawing or an altered item drawing. This adds costs and reidentifies the assembly from the true design activity number to the using activity number. This action item will be referred to the MIL-STD-130 preparing activity.

AMERICAN DEFENSE PREPAREDNESS ASSOCIATION

21ST ANNUAL MEETING - TECHNICAL DOCUMENTATION DIVISION

MAY 23, 24, AND 25, 1979

SPECIFICATIONS AND STANDARDS WORKSHOP
MAY 24, 1979

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THE SINGER COMPANY
KEARFOTT DIVISION
WAYNE, NEW JERSEY

W. A. MORAN - CO-CHAIRMAN
DOUGLAS AIRCRAFT DIVISION
LONG BEACH, CALIFORNIA

ATTENDEES: (18)

S. Alvine, Jr. (Chairman)	Singer-Kearfott Division, Wayne, N.J.
W.A. Moran (Co-Chairman)	McDonnell Douglas, Long Beach, Ca.
M. Walker	Century Graphics, Northridge, Ca.
J. Vovou	Pratt & Whitney, W. Palm Beach, Fla.
G.M.Lieblich	Global Engineering, Sant Ana, Ca.
P R.Pare	Aerojet Liquid Rocket, Sacramento, Ca.
H.D.LaMuska	Hdqt Samso, Los Angeles, Ca.
B.A.Vizzier, Sr.	PRC Technical Applications, Huntsville
C.F.Goessline	USA Missile Command, Redstone Arsenal
E.L.Hogan	Cubic Corp.,San Diego, Ca.
F. Corbett	Northrop DSD, Rolling Meadows, Ill.
R.E.Perri	Lockheed Missiles & Space, Sunnyvale
W. Heim	Naval Weapons Center, China Lake
A.D.Certo	Naval Air Systems Command, Washington
A.D.Signor	Naval Sea Systems Command, Washington
W.C.Morris	Hellfire Project, Redstone Arsenal
T. Harrison	USA MIRADCOM, Redstone Arsenal
D.Mitchell	Deputy Director, DOD Std/Spec Office

CHAIRMAN'S REPORT:

It has been almost 20 years since I became Chairman of the Preparation and Management of Specification Committee of the ADPA. Since that time, this field of documentation has become more widely used as more and more complex systems were conceived, developed and produced. We have seen the establishment of requirements for various types of program peculiar specifications and the practices to be used in their preparation, management and control. Today, they play a major part of every engineering data package. They are a part of the established management system

for the acquisition of equipments for DoD use. This includes the Systems Engineering, Configuration Management and Data Management functions that extend from concept through production and maintenance. Program pe culiar specifications address baseline management through each phase of acquisition.

At the last workshop a year ago, we were given first-hand knowledge of an effort combining the requirements of Mil-Std-490 and Mil-Std-961 to form one comprehensive set of requirements and practices for industry as well as the military to follow in preparing specifications. Unfortunately, when the actual combined standard was made available to industry and the military for review, it fell far short of the goals which were to be achieved.

One of the reasons given for the establishment of the combined standard was to facilitate the conversion of a program peculiar specification to a military specification. It was the unaninous opinion of many, that the chance of a weapons system family of program peculiar specifications ever being converted into a military specification format was extremely remote. Industry, in general, felt that the alleged conversion problems were vastly overstated, were not of such monumental or of cost incurring nature as to warrant the requirement presented by the combined standard.

A further review of the combined standard made it apparent that there would have to be an extensive re-evaluation of existing system management practices (DID's and other procurement devices) before it could be released for contractural use. The task of changing references, definitions, etc. alone is staggering. Additionally, it has taken industry 10 years to fully implement Mil-Std-490 and its associated documents. The changes that are included in the combined standard would tend to disrupt all the progress to date in the application of the Mil-Std-490 concept.

It was the understanding of many that the combined standard would be limited to editorial, language, and format practices. In this regard, the combined standard introduces new and confusing practices dealing with table numbering, page numbering and identification, section headings, appendix numbering, definitions, etc. The com-

bined standard offers nothing new to the management process, but rather imposes a host of "how to" requirements which are different from present requirements.

It is recognized that a considerable effort was put forth in the attempt to combine these documents into one comprehensive standard. However, the combining of these standards did not accomplish the results envisioned during the formulation of the plan. As a result, it was suggested that the program be discontinued.

It was also the consensus of many that any new efforts on the part of the DoD Standardization Office to improve specifications be aimed at updating Mil-Std-490 to include the applicable portions of Mil-Std-483. It was also recommended that Mil-Std-490 be updated as soon as possible to reflect the experiences gained by industry in applying this document contractually.

Everyone heard yesterday that the project for combining the two existing standards into one document was cancelled due to the overall negative response from the military as well as the industry. It was also stated that consequently we can all expect to see the pending revision to Mil-Std-961 be implemented soon and that the overdue revision to Mil-Std-490 will be forthcoming in the very near future. It is expected that the revisions to both of these documants will pick up and eliminate where possible those differing and conflicting requirements now existing between them in the editorial, language, and format practices.

QUESTION AND ANSWER SESSION:

1. Program Peculiar Specifications (as defined by Mil-Std-490) are used as a guide by one of the services (NAVAIR) to document an item during developement and initial production. ASPR/DARS requirements state that if they are used for more than one procurement that they be converted to Military Specifications. In reality, the requirement should be changed to convert them only when they are used in more than one application, permitting the use of program peculiar specifications for repeat procurement. In addition, program peculiar specifications normally go through many changes during the life cycle of a program. Military Specifications do not lend themselves to quick change/revision application. Mr. Mitchell informed the attendees that this problem area should be addressed in the forthcoming FARS replacing DARS 1-1202. NAVAIR should make special effort to have their voice heard during the comment/approval cycle of the proposed FARS. This is the vehicle for getting proper recognition for official use by the services to use program peculiar specifications for specific purposes.

2. Mil-Std-490 carries a requirement for "Documentation" in para.3.4 of the System and Type B Developement Specifications. How is this being responded to by Industry? First of all, the requirement for documentation does not belong in these type specifications but in a Statement of Work (SOW) or documents associated with a SOW. For years, the ADPA Specifications Committee has tried to get this requirement removed from Mil-Std-490 but as you all know we are still awaiting for a revision to that document. Its been almost ten years since it first was issued and used in contracts. At the present time, most of us are simply responding with "Not Applicable".

3. How does Industry handle classified information in a specification? The simplest way to handle this criteria is to put it in an Appendix to the basic specification and only have the appendix classified. For the same type of situation in the Mil-Std-961 system, the present version of this document does not adequately cover this technique. I understand the proposed revision will but will call the attachment an "Extract".

4. The effective use of tailoring techniques during the RFP stage was discussed extensively. Most companies are submitting two responses, one in total compliance and the other with tailoring applied. However, there has been some reluctance to participate in this DOD/Industry feedback effort because there is a belief that proposals are not safeguarded from competitors, that alternate proposals reduced Value Engineering Change Proposal possibilities, and that the cost of alternate proposals would not pay off unless the contractor won the competition.

5. Is the practice of defining multiple CI versions within a Mil-Std-490 Type B and C specification acceptable? I personnally have not seen todate any application of this technique to program peculiar specifications generated by Industry. I think it would be quite difficult to apply configuration management principals using type numbers to address different configurations. The Mil-Std-490 system permits the use of an Addendum Document to define the same type of item for a different mission and this is the one I've seen used most.

6. Will the DID's for Computer Program CI Part I and II Specifications shown in Change Notice 2 of Mil-Std-483 be updated? As far as I know the updating/revision of all DID's is one of the tasks in the overall Configuration Management Plan for the near future. I would assume the specific DID's I just mentioned would be first on that agenda.

7. In 4120.3m Chapter VII Section 2 (7-202,203,204) requires that the Contract Specification incorporate Configuration & Data Management activities and documentation (drawings, specifications, etc.). DOD Directive 5000.19 (Enclosure 5) para.V, C3 requires that all management systems and data requirements to be selected from DOD Directive 5000.19L shall be listed in a single location in solicitations and contracts (part of SOW). Which is the correct application? An action item was given to Mr. Mitchell to clarify and notify the attendees of his finding.

8. Information.
   a) Change Notice 2 of Mil-Std-483 (USAF) is being printed.
   b) The "Systems Management Newsletter" which is issued quarterly is yours for the asking by writing HQTRS, AFSC/SDDS,ANDREWS AFB, DC 20334, ATTENTION: Major T.L.LEIB, JR.

WORKSHOP #5
ILS/TECHNICAL PUBLICATIONS
MEETING REPORT

WORKSHOP PARAMETERS - The ILS/Technical Publications Workshop was conducted from 1345 to 1700 on May 24, 1979, in classroom 368, Ingersoll Hall, Naval Postgraduate School, Monterey, California. This workshop was a part of the Twenty First Annual Meeting of the Technical Documentation Division, American Defense Preparedness Association.

Workshop #5 was attended by 17 participants (6 military and 11 industry representatives). The roster identifies each participant by name and affiliation.

OVERVIEW - The Workshop Chairman convened the session by presenting a brief report on the status of last years action items. Two areas of follow-up action were reported. The first area involved ADPA's offer to assist Army personnel in presenting the Integrated Technical Documentation and Training (ITDT) concept and implementation procedures in a series of 5-day workshops to be held at East Coast, West Coast and Central cities. This workshop program is still pending but the concept is now identified as Skill Performance Aids (SPA). The second area involved assistance in the Technical Manuals Specifications and Standards (TMSS) program. We have contributed our effort to the industry team led by NSIA and joined by AIA. This Tri-Service Program is chaired by Mr. Roy Post at the U.S. Army Maintenance Management Center, Lexington, Kentucky. We contemplate considerable activity in future actions associated with TMSS.

After the introductory report, the purpose and operating procedures for the workshop session were given. During the General Membership Meeting (Session 1 on May 23, 1979), "Question/Problem" forms were distributed to all attendees and the five ADPA workshops and workshop chairmen were introduced. As a result of this solicitation, Workshop #5 received nine "Question/Problem" responses that were used as the workshop issues for discussion. To prepare for the discussion, each participant in Workshop #5 was asked to identify individual background information such as name, affiliation, position, and brief sketch of applicable experience. The Workshop Chairman then stressed that each participant should contribute to the session as an individual rather than as a representative of the affiliated

company or military service. Using this approach, the workshop objective was established as the resolution of "Question/Problem" issues that would best serve American defense preparedness.

Each of the nine input issues was addressed during the workshop session. Seven of the problems were resolved during discussion and two require follow-up action. Details of each issue follow with coverage of question asked, discussion highlights and resolution or follow-up action to be taken.

WORKSHOP ISSUE 1 - SPREAD OF SPA (FORMERLY ITDT)

QUESTION: The SPA concept (formerly ITDT) for Technical Manuals is being implemented by the Army, essentially changing "Technical Manual" content to "Training Manual" content. Does the Technical Documentation Division of ADPA know if this concept will be carried through to USAF, Navy, and Marine Corps of DOD?

DISCUSSION HIGHLIGHTS: Background information from the ADPA 20th Annual Meeting at New Orleans was discussed. Also, reference was made to the "AFALD Lessons Learned Bulletin-Technical Orders" furnished by Major L. Nesbitt. Concepts such as Logistic Support Analysis, user oriented instructions, full validation and verification, cross feed of on the job training and multi-media presentation were highlighted. These concepts were then related to current TMSS efforts.

RESOLUTION: By virtue of the TMSS effort, the concepts will certainly be examined by the tri-service program. It is highly unlikely that SPA will be applied across the board. It is more probable that the key elements of the concepts will be applied in unrecognizable SPA form.

WORKSHOP ISSUE 2 - PROLIFERATION OF DID's

QUESTION: Can the ADPA Technical Documentation Division address a problem with the proliferation of mods, addenda, attachments to Data Item Descriptions (DID's) when the DID's are inserted on the DD1423 in IFB's, RFQ's, etc.? The mods, addenda, and so forth, are destroying the intent of MIL Specs to standardize the form and contents of data items.

DISCUSSION HIGHLIGHTS: The basic use of the "grocery list" approach to identifying contractual data items was discussed. This led to a discussion of how the many service organizations implemented the DOD guidance. Reference was made to the major ADPA effort of the 70's that did make recommendations in each of the categories (including the "H" category). The time and effort expended by ADPA membership did not result in any noticeable change nor did we realize an interface discussion.

RESOLUTION: Before ADPA attempts another pass at reducing DID proliferation, we will be sure to establish firm communication commitments at the initial phase of such a program. (In the subsequent briefing to the general membership, assistance was offered to the Data Management Section of ADPA. This assistance will take the form of passing along the results of our earlier effort.)

WORKSHOP ISSUE 3 - TRAINING AND QUALIFICATIONS - TECHNICAL AUTHORS

QUESTION: What is the United States doing about training and qualifications for technical authors and communicators?

DISCUSSION HIGHLIGHTS: Reference was made to an ADPA Technical Publications Section sub-committee study conducted in the 60's. This study

had concluded that the diversity of government and industry needs precluded attempts to establish training and qualification guidelines. Discussion of current practice within workshop participant organizations highlighted that such diversity continues.

RESOLUTION: Based on the earlier study and current trends, ADPA does not intend to trigger a new effort on this issue. The UK representative was given the following follow-up leads to assist in his study:

East Coast:	Rensselaer Polytechnic Institute (Writers Institute)
	Brooklyn Polytechnic Institute (BS - Technical Communication)
Central:	University of Illinois
West Coast:	UCLA (Seminars)

Also, the Society of Technical Communicators was recommended as a contact point. These references were not identified as a complete listing but rather as excellent starting points.

WORKSHOP ISSUE 4 - PREMATURE ACQUISITION OF PRODUCTION DATA

PROBLEM: Resolve the premature application of full-up specifications and standards to ILS disciplines/elements, LSA, LORA, Technical Manuals, Training, etc., for development programs.

DISCUSSION: This problem induced a thorough discussion of tailoring of specification and standards to program needs. Reference was made to an initial TMSS input from ADPA that called for attention to tailoring of requirements. Communication with ILS customer counterparts at the early contract stages is essential to clarify intent and avoid misinterpretation.

Alternate approaches are now encouraged by most RFP's. The climate for resolving such problems is much improved by use of life cycle cost analysis.

RESOLUTION: Implementation of tailoring techniques on a program need basis is now encouraged by DOD. This avenue of approach also provides increased communication capability with customer counterparts.

WORKSHOP ISSUE 5 - FUTURE TRENDS IN DEMAND FOR DOCUMENTATION

QUESTION: What is the future direction/emphasis of technical documentation, particularly with respect to technical manuals, metrication, micro reproduction, PMS, etc.? Will requirements to contractors be increasing or decreasing?

DISCUSSION HIGHTLIGHTS: Reference was made to the DOD activity summary given at general membership Session II. The GAO interest in technical manuals was related to the USAF and USN retrenchment from micro reproduction and the costs of earlier investments. This would indicate that future trends in micro reproduction are subject to very careful analysis. Discussion brought out the relatively slow but steady trend toward metrication. Perhaps the greatest impact will be felt as a function of technology progression. Built in test equipment (BITE), preventive maintenance (PM) and fault localization (FL) circuitry in current systems were discussed and related to demands for documentation. Participants were asked to review the 10-year forecast made by AIA at the start of the 70's. Much of that forecast could now be applied to our forecast for the 80's.

RESOLUTION: Progress in technology will provide the key to future trends. We can only be assured of continuing change. Hopefully, progress will continue in manageable doses.

WORKSHOP ISSUE 6 - MAKING MAXIMUM USE OF EXISTING REPRO

PROBLEM: Specification MIL-M-38784A does not contain provisions for use of "lifts" from existing books done to prior revisions or different specifications. (A statement such as that contained in DOD-D-1000 for existing drawings is recommended.)

DISCUSSION HIGHLIGHTS: Discussion highlighted the contractual implementing documents. Tailored to specific program needs, it is in such documents that encouragement or discouragement of "lifts" is given. Placing such a statement in the technical manual specification would be a mistake but data acquisition personnel must be made aware of this approach.

RESOLUTION: No attempt will be made by ADPA to add such a statement to MIL-M-38784A. Perhaps the TMSS Tri-Service committee could be encouraged to improve the awareness of data acquisition personnel to the proper use of contractual implementing documents where this issue is applicable.

WORKSHOP ISSUE 7 - IMPACT OF AUTOMATION

QUESTION: What influence will the growing use of word processing have on Technical Manual specifications and the update of out-of-production equipment manuals?

DISCUSSION HIGHLIGHTS: Reference was made to the recent AIA and NSIA Symposia on automation. The term "word processing" was quickly modified to mean "text processing", "graphic processing", and "integrated text and graphic processing". With very few exceptions (NARF, Jacksonville's THUMP, NSWSES's ADREP's) surprisingly little influence has been felt to date. Recent advances in OCR capability were used to show that the potential is ever increasing and that we should expect major influence

in the relatively near future. A word of caution was sounded in the discussion that only one source can be used at a time to assure configuration control of technical manual change.

RESOLUTION: ADPA will continue to encourage participation in AIA and NSIA Symposia and will not parallel the very fine efforts of these organizations. ADPA will continue to provide a sounding board via workshops to examine trends and influences. Look for restrictive use of photographic coverage in Technical Manuals brought about by increased use of digitized line artwork.

<u>WORKSHOP ISSUE 8</u> - MIL-M-38784A LETTERING SIZE REQUIREMENT

PROBLEM: MIL-M-38784A calls for 8 (min) to 10 (max) point character size on illustrations. This requirement is ambiguous and interpreted differently by various customers. A change notice to this specification is required to clarify this point.

DISCUSSION HIGHLIGHTS: Discussion brought out that somewhere in the translation of the older 5474 specification, the requirement was refined from "80 letters" to "8 point". Using "80 letters" is a safe approach to insure legibility and spec compliance. Using the "8 point" requirement could be troublesome if the interpretation is that "80 letters" was intended. This issue should be brought to the attention of the TMSS Program for action.

FOLLOW-UP ACTION: ADPA will address this problem to the TMSS Program office at the earliest opportunity.

WORKSHOP ISSUE 9 - SPECIFICATIONS FOR "LESS THAN WEAPON SYSTEMS"

PROBLEM: It is difficult to prepare comprehensive and well organized Technical Manuals due to restrictive requirements of MIL-M-15071G (US Navy). This Technical Manual specification is directed toward more generalized and standardized mil-specs.

DISCUSSION HIGHLIGHTS: There were two distinct rounds to the discussion of this problem. The first round led to the conclusion that much could be done within the existing framework of tailoring to achieve the desired approach. Aegis was cited as an ideal example of how an enlightened program office in the service organization could both encourage and implement innovation. It wasn't until the discussion reached a much different second round that the workshop participants appreciated that this was the plea of a contractor involved in "less than weapon system" equipment. Both the specification requirements and lack of communication channels to resolve interpretation were then brought out as areas needing attention. It was determined that a study of this acquisition area was needed.

FOLLOW-UP ACTION: ADPA will encourage the TMSS Program to include this issue in one of the future discussions. ADPA will encourage a study of this problem to ensure that adequate focus is provided to "less than weapon systems" Technical Manual coverage.

RECOGNITION: Special thanks are in order for the excellent setting provided by the Naval Postgraduate School, Monterey, California.

Also, the attendance and active participation of R. D. Kemp, Maj. L. Nesbitt, and S. L. Simmons did much to achieve the communication level that was realized. Although not established as a formal panel, these men formed the backbone of the workshop session.

WORKSHOP #5

ILS/TECHNICAL PUBLICATIONS

ROSTER

Name	Affiliation
Richard E. Knob	Sperry Gyroscope
R. Leon Snodgrass	EG&G, Inc.
David Blackstone	Ingersoll-Rand Co.
Gary L. Blackly	Ford Aerospace
Bill Brossman	AVCO-LYCOMING
E. A. Woodward	Honeywell
E. C. Lacz	NAVSEA PMS400F35
K. E. Radcliff	NSWSES (NSDS A)
Rodger Wilson	FMC Corp., Northern ORD.
S. L. Simmons	NSWSES (5130)
J. F. Courtney	Vought Corporation
L. L. Glowienka	Ken Cook Company
Maj. L. Nesbitt	AFALD/PTQS
R. D. Kemp	RCA
Lt.Col. (Rtd) R. D. French	Min. of Defence (UK)
B. J. Bretz	U.S. Army MERADCOM
C. D. Fisher	RCA

SESSION 5

Chairman: CHARLES D. FISHER
RCA Corporation

Secretary: JOSEPH F. ARMIJO
Tracor Incorporated

METRICATION OF TECHNICAL DOCUMENTATION

JACK L. WILSON
Chairman, California Metrication Committee

NOTE: This paper was transcribed from a recording of the session.

Happiness was described a few minutes ago as having a full tank of gas. That being the case, maybe unhappiness is leaving home with something less than a full tank of gas and having to drive 350 kilometers on an odd day with even license plates.

I was somewhat overjoyed at being asked to address this session. Contrary to ordinary belief, I am not a charter member of ADPA; however I have been a life member for a very long time. I am not a stranger to this organization.

Several years ago I made a study of my own company as to specifications, standards, and other professional documents that would be affected by implementing the metric system of units. When the total came to something around 900,000, I quit, but what we are talking about is something that is really not strange--it is something that is more frightening.

I would like to lay the groundwork a little bit here. I am reminded of a story. I don't know why I should be reminded of it; it's a Navy story. It seems that this midshipman back in the Naval Academy was asked to give a briefing on an engineering problem to a group of staff officers. When he walked into the lecture room, he looked around and had never seen as much gold braid in all his life. So with typical aplomb which they teach at the academy, he said, "I am sure there are one or two people that know more about this subject than I do, but I don't see either one of them in the audience."

I can't say that here. I look around here and I see quite a few people in this audience whom I know know more about this subject than I do, but I have the advantage. I am up here; you are down there. So let's start from the beginning.

When we start talking about making changes, particularly changes in systems of units, people begin to panic. All of a sudden engineering drawings don't look the same. People begin to worry. Things don't appear as they should. Everybody says you can't do it. They might be right, I don't know. Nothing goes right. Even for the "do-it-yourselfers", things go wrong. But when we talk about implementing metric units into technical documentation, it

seems like things go dark. It seems like things get puzzled. (Indistinguishable masses of light and dark were projected onto the screen. They vaguely resembled an igloo in a snow storm.) I am going to go back to this particular slide a little later on because it is one of my favorites.

But when we talk about implementing the metric system of units, the thing that bothers most people is that they have been taught to think "big". What do we mean by thinking "big" in implementing metric units? Well, let's take an example. This is not an example of a problem with technical documentation, but it is typical of the kinds of problems which can occur in technical documentation. This situation involves a can of macadamia nuts from Hawaii. It is clearly identified as having a weight of sixteen ounces, or one pound, and then comes the clincher, the 453.59 grams. That's all well and good; however to be exact, they really should have said that it was 453.59 and 3/7 grams. Then that one pound would be exact. However, when I sent the can of macadamia nuts to my laboratory and actually weighed the contents, it was not 453.59 grams, but was 427.37 grams. Now let me tell you why:

Five significant figures indicate an accuracy of the one pound to at least four places. Macadamia nuts are not packaged by mass, they are packaged by count. An average number of macadamia nuts weighs approximately one pound. The intent was not the mass as indicated by the "net weight" (as it is called). That package, if you were to measure it, is almost exactly ten centimetres on a side. It has a volume of 1000 cubic centimetres or one cubic decimetre or, by the grace of the General Conference of Weights and Measures, a special name for that is one litre. What is intended in that package is that approximately one pound of macadamia nuts occupies a volume of one litre. Now that is not evident from the labeling, and that is the problem with much of the metrication in technical documentation-- it fails to say what it means.

Now let me give you some additional examples. This is the nameplate of of a vacuum pump that is on the market today, an excellent pump, by the way, if you ignore what it says here. The twenty-five litres a metre ("25 L/m") is meaningless. What they meant was twenty-five litres per minute (25 L/min), but they didn't use the proper symbology. Symbology is the secret of metric implementation.

Let's go on. Let's see what happens when we take very common things and we convert them to metric units--conversion is the problem.

The Golden Gate Bridge which spans the entrance to San Francisco Harbor is a beautiful structure, but let me tell you what it stands for when its dimensions are given metrically. For example, on a cold day due to the contraction of the cables, the center of the center span will lift 1.5 metres. On a hot day, it will sag three metres. On a normal windy day the center of the center span may sway as much as eight metres. Now those of you who have

driven across the Golden Gate Bridge on a windy day in a small car know that it is not uncommon to be notified that small car warnings are posted--your car can change lanes without even trying. Driving across that bridge on a windy day is just like crabbing an aircraft or boat into the wind; it is not an easy chore. But the important thing about that bridge is that from the center of the center span, the surface of the water at mean low tide is a little over 67 metres. Now, what that means is that a couple of the sailing ships that came into San Francisco around the turn of the century could not have passed under that bridge. One of these ships happens to have had a height from the top of the main mast to the waterline of a little over 90 metres (296 feet). A second one was 78.9 metres high. Even these early ships couldn't pass under there.

The aircraft carrier USS Enterprise has some excellent characteristics, but the height from the waterline to the top of the superstructure is a little over 69 metres. That means that the Enterprise cannot come under the Golden Gate Bridge even at mean low tide. That proved embarrassing to the Navy because the Enterprise happens to be stationed at the Alameda Air Station which is inside San Francisco Harbor. In fact, not only does the Enterprise have to come under the Golden Gate Bridge, it also has to make a 90 degree right and go on to the Bay Bridge. The Bay Bridge also has a design specifications of 67 metres from the bottom of the center span of the incoming lane to the surface of the water at mean low tide. All right now, how do we get the Enterprise into the harbor?

Well, I've made several telephone calls to the Naval District Headquarters in San Francisco and I called BuShips in Washington and a few other places. The answers I got ranged from "Very carefully", "We select the conditions under which we do it", "I frankly don't know", to "If you really want to know why don't you wait until the Enterprise is in the Air Station and call the Captain? He will tell you."

Well, being a little bit chagrined about this time, I waited until the Enterprise came into the Air Station, but I didn't go down and ask the Captain. My son, who is an officer in the Civil Air Patrol, was taking his squadron on a tour of this ship. I told him to ask one of the Engineering Officers how they get that big ship under these bridges? Without a moment's hestitation, the Engineering Officer said, "It is quite simple--we pump all of the ballast from port to starboard, which causes the ship to list slightly over 7-1/2 degrees. This enables us to clear the bridge." Anyone who believes that will believe anything.

What actually happens is that part of the superstructure is lowered and part of it lays back so that, with care, it will come under the bridges. The total height then is something less than 67 metres. Furthermore, the difference between the "as-designed" and "as-built" configuration of the bridge is such that there is actually almost 70 metres from the bottom of the span to the surface of the water at mean low tide.

Just like in the manufacturing industry, in spite of all of the specifications and standards that made up the engineering, the final emphasis is to hammer, saw, and file to fit in the assembly. In the marine and shipbuilding industry, they phrase it another way: "Heat and beat to meet". And just to show that the Air Force is not immune, their phrase is "We measure it with a caliper, mark it with a pen, and cut it with an axe."

Now what is the problem with metricating technical documentation? The problem is fear of the unknown. There is nothing strange about it. All you have to do is remember a few salient rules. The rules are symbology, the correct system, and the proper application.

Let's look at this picture again (the igloo in a snow storm?). Is there anybody that hasn't figured it out by now? That big black blob is an ear and that big black blob is an ear. That is an eye, that is an eye, and that is a nose. (Immediately a clearly discernable picture of a Jersey cow emerged from the gray masses.) Once you have stopped to take a good long, hard look at a metricated technical document, you have your sacred cow right back with you.

Technical documenation simply means presenting in technical terms a description of something. It may be written, it may be verbal, it may be graphical, or it may be pictorial. But we are describing something in technical terms. Technical documentation must be correct, it must be factual, it must be realistic, and must be understandable by those who need to understand. Correct usage of SI metric units is essential.

I have to mention I am the Chairman of one of the ANSI Standards Committees. I have written standards and specifications for over twenty-five years. It is not easy. I have also used systems of measure for a considerably longer period of time.

I have here a little document called "Pressure Conversion Factors" which is published by a manufacturing concern. In addition to the common systems of pressure (pounds per square inch), this booklet contains twenty-five conversion factors for other units designating the same thing. In the new scheme of things, only one of the twenty-five units is correct; that is the pascal. This booklet even misspells "pascal". In implementing the SI metric units, we must be careful to avoid being misled by such publications.

I am talking about the implementation of a single system of units, the International System of Units, officially abbreviated "SI" in all of the languages of the world. It is an outgrowth of one of the organizations set up by the International Treaty of the Metre. It is the only metric system that will remain in existence in the future. It is the one form to which many metric nations of the world are voluntarily changing. It has many advantages. It is truly an international system. It is not a system that can be unilaterally changed by any one of the nations, despite the

wording in the Metric Conversion Act of 1975 in the United States which stated that the system of units referred to by that law was the International Systems of Units as interpreted and/or modified by the Secretary of Commerce.

There have been several recommendations made by our U.S. representatives to the international committees. Some have been accepted. Some have yet to be worked on. For example, I mentioned the litre deliberately because it has been decided that capital "L" will be used as the symbol for litre in this country. That symbol has not been accepted by the General Council of Weights and Measures. It has been accepted by the International Committee of Weights and Measures and will be submitted to the General Council of Weights and Measures at the next meeting. Officially, today, and since 1960, the symbol for "Litre" is small "l" and if there is a chance for confusion between that and the number one, then you spell the word out. In fact, that is one of the cardinal rules in implementing the International System of Units--when in doubt, spell it out. Do not use wrong symbology; do not select your own symbology.

The International Committee of Weights and Measures (the United States is a member of that committee) has agreed to accept the standards published by the International Organization for Standardization (ISO) Technical Committee Twelve (TC12). There is a full set of standards on the units to be used and on how they should be used.

We have a unique situation existing in the United States in that we have two metric practice documents designated as the national standard by the American National Standard Institute. These documents are written by two different professional organizations. This is a first and, hopefully, will be a last. Hpefully, it will be corrected. The difference between the two documents is stupid. It is how to spell metre and litre. But we won't get into that one either.

What does it all amount to? This is it: the United States is going metric. Despite the vocal few who say that it will never happen, it is really their last great act of defiance.

Now let me give you an example. When I say we're going metric, I'm not saying we are going to change everything, because we certainly aren't. I am retiring from Sandia later on this summer and moving back to the Midwest, to Indiana. I can still find some old-timers back there that if you ask them how far it is to a certain place, will answer, "Down yonder a ways." Now think about that a minute. "Down yonder" is a very positive, definitive distance to them. From point "A" to point "B" is "down yonder a ways". That takes into consideration the gravitational pull of the moon, the spin of the earth, the tide, the wind, the time of the year, and everything else. There are no tolerances involved. It is a fixed distance. You go far enough that way and you get there.

You go over to Appalachia and they even have a more definitive definition of distance and that is so many "hoots and hollers". Now for those who are not familiar with hoots and hollers, it means that you are too young to remember prohibition and moonshine. When the flatlander approached the hills of Appalachia, their way of warning the moonshiners that someone was approaching was to hoot like an owl from one hill to next across the hollow. That's your hoots and hollers.

When we implement the metric system of units, we are not changing "down yonder a ways", we are not changing so many "hoots and hollers", we are not changing things that don't need to be changed. We are merely implementing an international system of units in places where international units need to be used.

Although I happen to be concerned primarily with quality assurance and quality control, I am not totally unfamiliar with technical documentation. If you don't use proper units in documentation--be it quality assurance, quality control, or technical documentation--the result is not as meaningful as you intend it to be.

So, we are going metric whether you want to or not--be prepared. And I am going back to Livermore and back to my sick bed. I hope to find some kind filling station in Monterey and we will overlook the fact that this is an odd day.

Thank you.

COMPUTER
MASTER
PARTS LIST

<u>NOT</u> ANOTHER COMPUTER PREPARED ENGINEERING PARTS LIST PRESENTATION

by ROGER A. STORMS, MANAGER

ENGINEERING, TECHNICAL DOCUMENTATION
SPERRY UNIVAC – DEFENSE SYSTEMS
ST. PAUL, MN

SPERRY UNIVAC

Presented to:
AMERICAN DEFENSE PREPAREDNESS ASSOCIATION
TECHNICAL DOCUMENTATION DIVISION
TWENTY-FIRST ANNUAL MEETING
MONTEREY, CALIFORNIA

COMPUTER MASTER PARTS LIST

ROGER A. STORMS
SPERRY UNIVAC DEFENSE SYSTEMS
ST. PAUL, MN.

EXECUTIVE SUMMARY

This paper explains how one military contractor utilized a controlled computer data base as the "master" for engineering parts list (PL) data to eliminate PL hard copy storage and microfilm costs from its technical documentation operations. The paper discusses the disciplines and controls necessary to utilize a computer data base as the "master" for engineering technical data. It also defines the enhancements required to a typical Automated Data Processing (ADP) system used only to prepare MIL-STD-100 Parts List to allow its data base to be a master for the company's engineering parts list data.

DEFINITIONS

PL - Parts List per MIL-STD-100 prepared with Automated Data Processing (ADP) methods. See PDS.

ADP - Hardware/Software System used to process and prepare data. See 1100.

PDS - Sperry Univac Product Definition Information System (PDS) operating on 1100 Series Computer, used as an identification data base and to prepare engineering parts lists per MIL-STD-100.

ACS - Sperry Univac Active Change Status (ACS) Information System operating on 1100 Series Computer, used to status and control engineering changes per DOD-STD-480A, MIL-STD-483 and MIL-STD-482.

1100 - SPERRY UNIVAC® 1100 Series Data Processing (Computer) System.

UNISCOPE® terminal - SPERRY UNIVAC display terminal.

BACKGROUND

Sperry Univac Defense Systems started using a computer to prepare a detached engineering parts list (PL) in 1962. From that point on, it continued to store the current computer prepared PL in an engineering vault as the "master" and to microfilm all revisions of the engineering PL for history. In the fall of 1977, Sperry Univac stopped storing computer prepared engineering PL's in the Technical Documentation Center (vault) and stopped microfilming of the engineering PL's. This was done after the implementation of a one year technical documentation support software enhancement project.

DESCRIPTION OF FORMER PL SYSTEM

Based on engineering authorization and change board approval reflected in the Active Change Status (ACS) Information System, engineering parts list data was input to the Product Definition Information System (PDS). The PDS System then prepared a PL hard copy master which was checked, microfilmed and distributed to satellite files in aperture card format. The latest PL hard copy was stored in the Technical Documentation Center (vault) as the "master" and a microfilm history file was maintained of each PL Revision. On receipt of PL hard copy "master" in the vault for filing the change was closed out in the ACS System. See Figure 1 for flow diagram.

DESCRIPTION OF PRESENT PL SYSTEM

Based on engineering authorization and change board approval reflected in the Active Change Status (ACS) Information System, engineering parts list data is input to the Product Definition Information System (PDS). The PDS System verifies that the PL change has been approved in the ACS System. The PDS System is then updated and change data is stored in the data base. The PDS System data base is checked against the approved engineering change and the change is then closed out in the ACS System. Disaster tapes are maintained for all technical data in the PDS System data base. PL data is available on UNISCOPE terminals throughout the SPERRY UNIVAC 1100 network in various tailored formats. PL hard copy is available in UNISCOPE terminal format at any UNISCOPE terminal printer. PL hard copy in MIL-STD-100 format at any desired revision is available on request. The PL hard copy in MIL-STD-100 format is generated on high speed printers at the Sperry Univac facility making the request. See Figure 2 for flow diagram, Figure 3 for 1100 network and Figure 4 for typical PL hard copy in MIL-STD-100 format. The present PL System <u>does not</u> include a microfilm on a PL filing task.

FORMER PL CHANGE FLOW

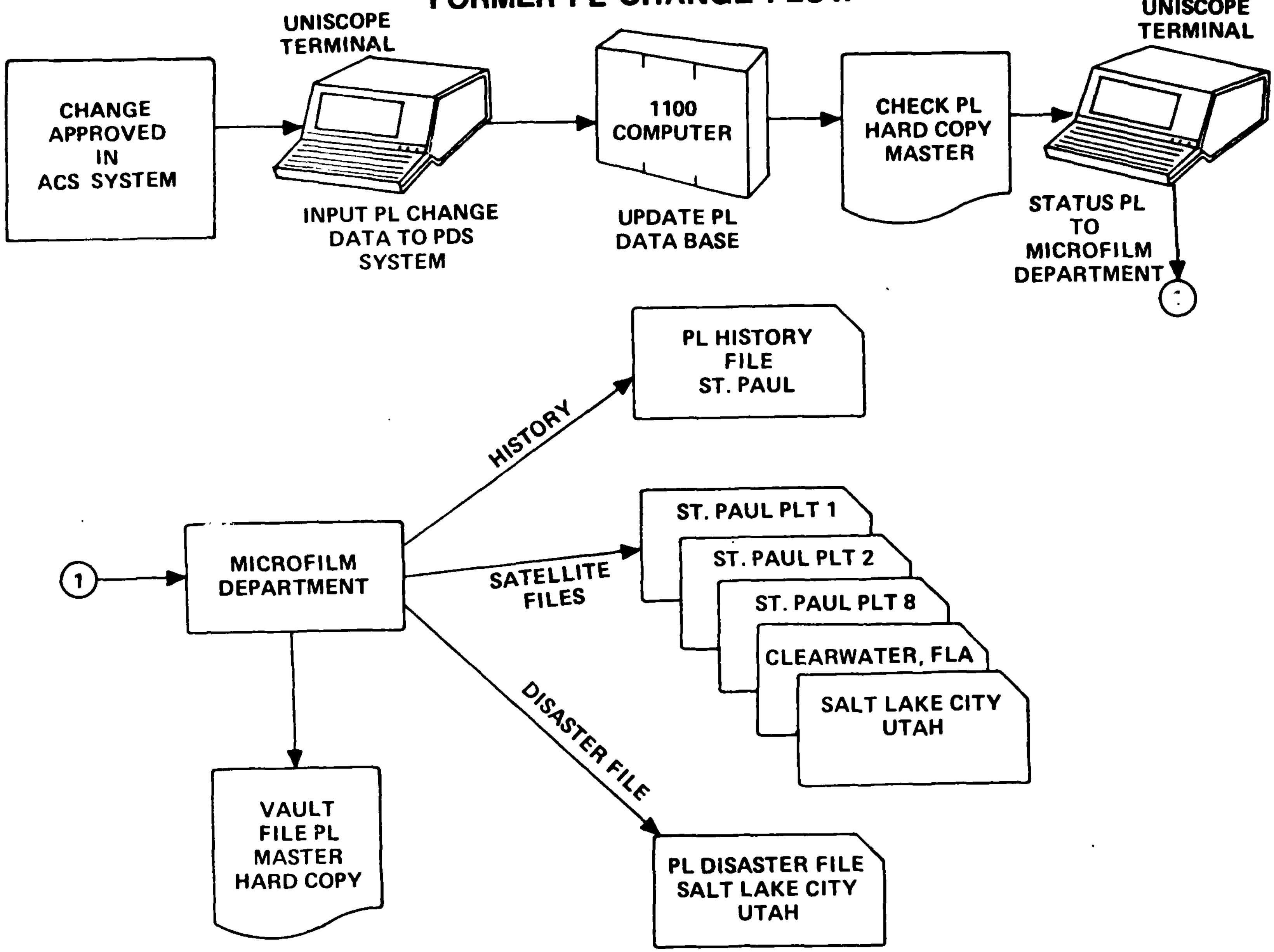


Figure 1

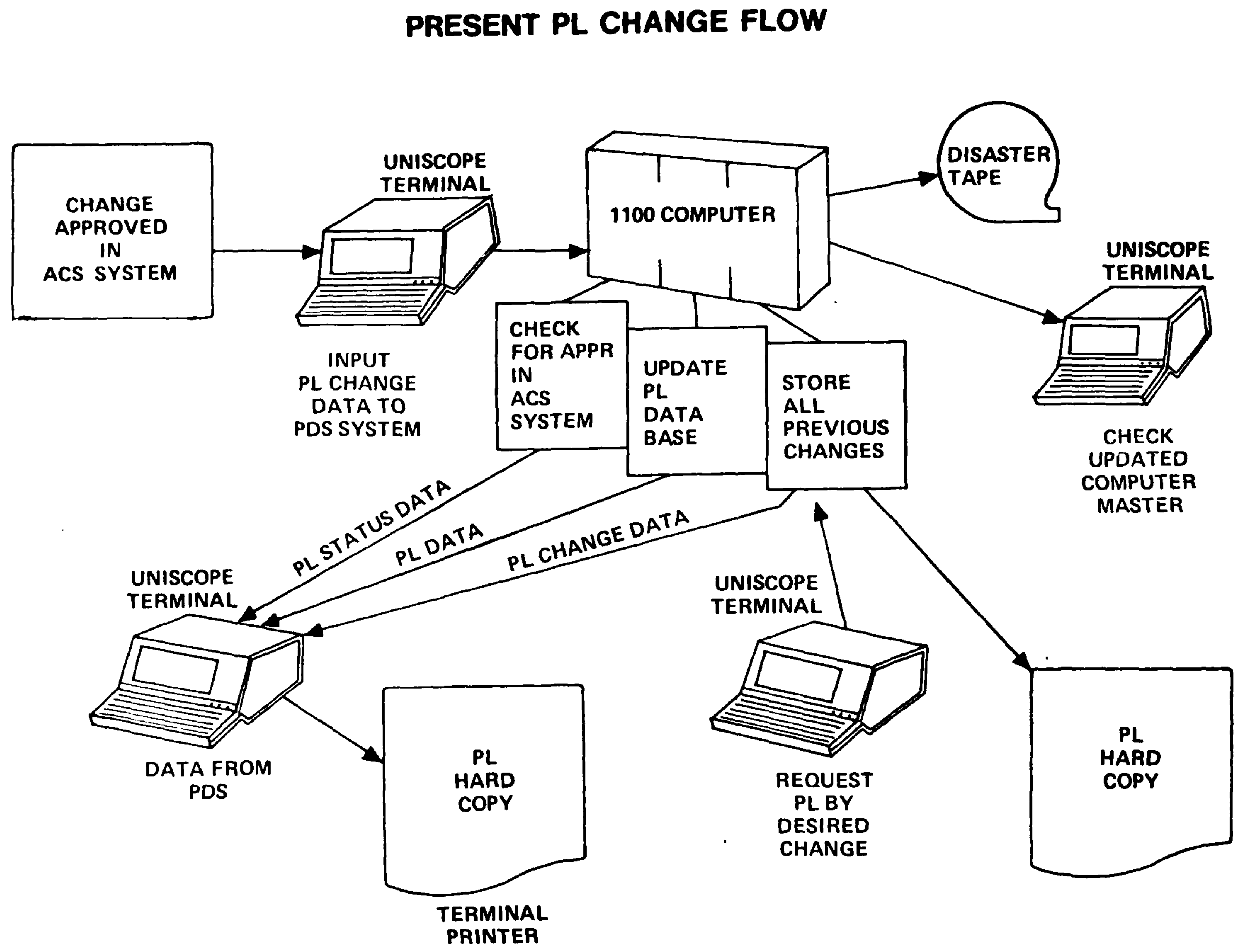
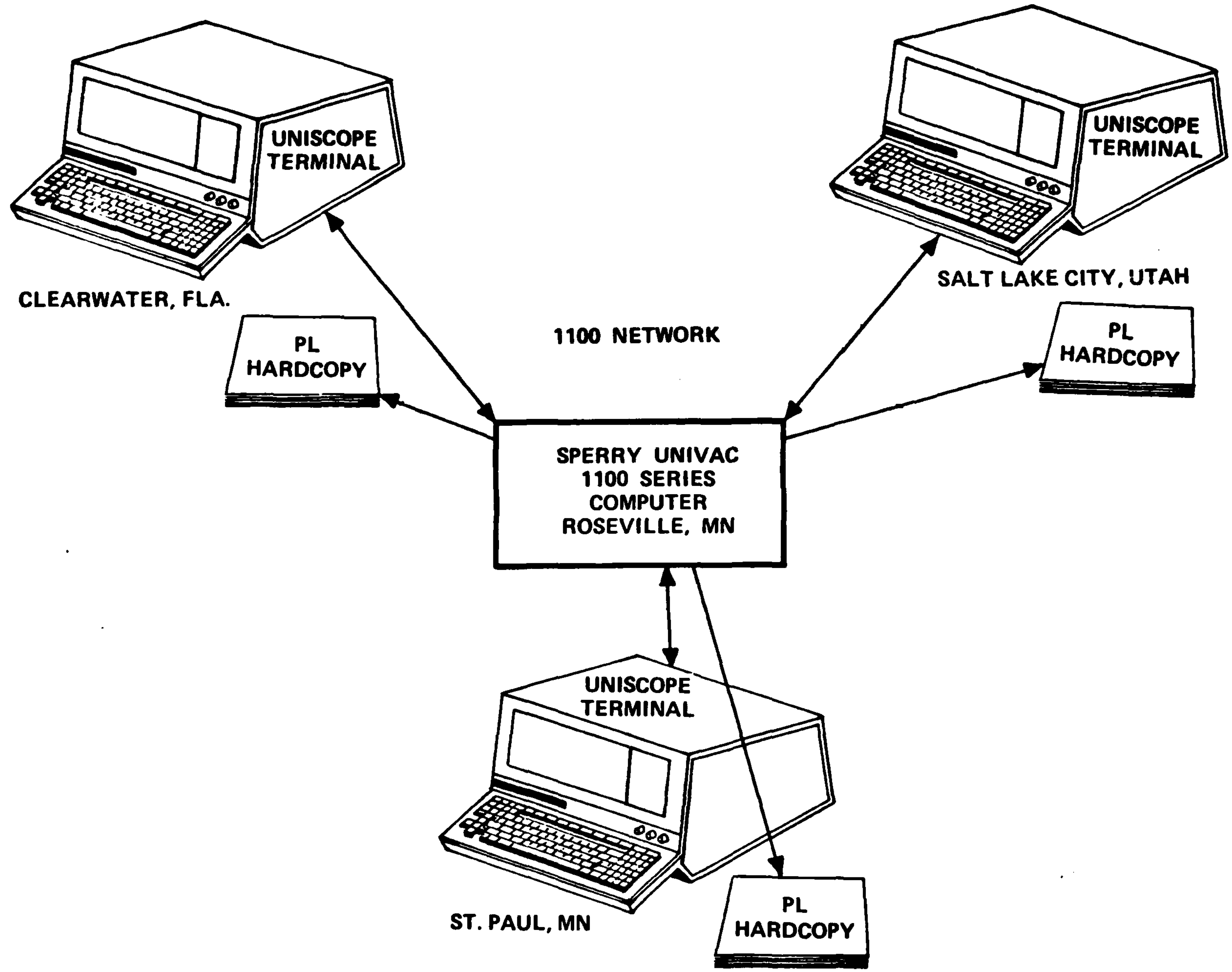

PRESENT PL CHANGE FLOW
CHANGE APPROVED IN ACS SYSTEM
UNISCOPE TERMINAL
INPUT PL CHANGE DATA TO PDS SYSTEM
1100 COMPUTER
DISASTER TAPE
UNISCOPE TERMINAL
CHECK UPDATED COMPUTER MASTER
CHECK FOR APPR IN ACS SYSTEM
UPDATE PL DATA BASE
STORE ALL PREVIOUS CHANGES
PL STATUS DATA
PL DATA
PL CHANGE DATA
UNISCOPE TERMINAL
DATA FROM PDS
PL HARD COPY
TERMINAL PRINTER
UNISCOPE TERMINAL
REQUEST PL BY DESIRED CHANGE
PL HARD COPY

Figure 2



UNISCOPE TERMINAL
CLEARWATER, FLA.
PL HARDCOPY
1100 NETWORK
UNISCOPE TERMINAL
SALT LAKE CITY, UTAH
PL HARDCOPY
SPERRY UNIVAC
1100 SERIES
COMPUTER
ROSEVILLE, MN
UNISCOPE TERMINAL
ST. PAUL, MN
PL HARDCOPY

Figure 3

```
PARTS LIST     CONTRACT NO        FSCM NO                          DASH RANGE  REV REV DATE SHEET
                                   90536       PL 7309396            00-01      A 79-04-20   1

TITLE: PC KIT                            REV AUTH NO               PIC REV
                                          BD134500-001                 -

UNIVAC DATA---PC:NT DT:D DL:3 DS:A NDS:002 VL:Z RC:S UM:EA DI:   ST:A      PDS FILE DATE: 79-04-20


- - NOTE LN DOCUMENT NOTES - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
      1   1  PC REPAIR KIT

- - - - - - VARIABLE - - - - - - - - - - - - - - VARIABLE - - - - - - - - - - - VARIABLE - - - - - - - - -
      DASH  SECOND LINE TITLE                      FSCM   GOVT/VENDOR NO            SPEC NO
        00  W/O SOLDER
        01  W/ SOLDER
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

         DASH
ITEM   RANGE    QTY UM  FSCM PART/MATL/SPEC NO        PART/IDENT NO        TITLE/DESCRIPTION/NOTES/REF DES
  1    00-01      4 EA          7312454-00               7312454-00        CIRCUIT CARD ASSY--
                                                                            MICRO REGISTER BOARD
                                                                            J2       THRU     J5        1
  2      00       2 EA          7312438-00               7312438-00        CIRCUIT CARD ASSY--
                                                                            SERIAL INTERFACE MODULE
                                                                            J1       J6                 1
  3      01       1 EA          7312450-00               7312450-00        CIRCUIT CARD ASSY--
                                                                            MAINTENANCE DISPLAY DRIVER
                                                                            J6                          1
  4      01       1 EA 81349 MIL-R-83401/1               7905334-48        RESISTOR NETWORK-- FIXED,FILM,
                             M8340101-M1001GB                               1 WATT, 1000 OHM, +-2%
                                                                            USE FOR NULL BALANCE
                                                                            R1                          1
  5      01       1 LB       QQ-S-571                    7956348-99        SOLDER, LEAD-TIN ALLOY--
                                                                            SN60/SN63,TYPE S,R,RMA,P2/P3

- - - - - - - - - THE FOLLOWING S ITEM NUMBERS IDENTIFY SPECIFICATIONS - - - - - - - - - - - - - - - - - - -
S01     ALL        EA          MIL-STD-130              MIL-STD-130         IDENTIFICATION MARKING OF U.S.
                                                                            MILITARY PROPERTY

- - - - - - - - - THE FOLLOWING Z ITEM NUMBERS IDENTIFY ENGINEERING CHANGE AUTHORIZATION

                                              PL   PIC
ITEM     REV AUTH NO          REV DATE     REV  REV         CHANGE NOTES
Z002      BD134500-001         79-04-20     A    -          ADD MARKING SPEC
Z001      BD134492-001         78-10-23     -    -

- - END - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - SHEET   1 OF   1 - - - - - -
```

Figure 4

W-7

UD1-2996 (REV. 11/77)

NECESSARY DISCIPLINES AND CONTROLS

The following disciplines and controls need to be in operation to install the computer "master" data base concept:

1. Documented change data.
2. Engineering Authorization and change approval status accounting.
3. Responsibility for data integrity assigned to each identified document in data base.
4. Effective data checking function.
5. Effective data security (disaster) methods.
6. Effective data communication/distribution.

An ADP System can not overcome deficiencies in the above.

ADP ENHANCEMENTS

Assuming that a typical ADP System is in operation and used to prepare MIL-STD-100 Parts Lists, the following software enhancements are required to use the ADP System data base as the "master" for the engineering parts list data.

1. Software verification that change is approved prior to update of data base.
2. Storage of change history data in data base by change approval number.
3. Capability to prepare engineering PL at any desired revision.
4. Identification in data base of organization and location responsibility for data base integrity by document number.
5. Input data software validation and error reporting to responsible organization and input organization.
6. Disaster backup capability for data base.

CONCLUSION

This case in point presentation depicts a step towards "true" software configuration management. Only with many more steps can we expect to realize the total benefits that automation can bring to the world of Technical Documentation Control. We can not afford the hard copy "master" control method for technical documentation prepared with Automated Data Processing (ADP) methods.

AUTOBIOGRAPHY

Roger A. Storms is a manager of the Technical Documentation Control department within Engineering at Sperry Univac Defense Systems. Defense Systems Division is a major supplier of reliable and ruggedized information handling products and systems for the Department of Defense. Roger obtained his B.S. degree from Iowa State University in 1965 and his M.B.A. degree from Wichita State University in 1969. He joined Univac in 1969 after working for The Boeing Co. Since joining Univac he has held various supervisory/management positions, including Quality Engineering supervisor, manager Configuration Management and manager Technical Documentation Control responsible for Configuration Management, Data Management, Data Control, Data Storage and Documentation Systems and Procedures.

COMPUTER GRAPHICS

AND

ENGINEERING DOCUMENTATION

R. D. RHODES
LOCKHEED SPACE AND MISSILES COMPANY
P. O. BOX 504
SUNNYVALE, CA.

Computer Aided Design and Computer Aided Manufacturing is a development that has literally exploded on the scene. It has proven to be a natural extension of the designer's mind as the hand-held calculator has become an aide to the professional accounting ranks.

Computer design graphics is a technological innovation whose time has come, but two factors have speeded up the process. First, engineers are not as available as they were in the 1960's. Fewer and fewer young men and women have chosen an engineering profession. Secondly, the price of computer hardware has been plummeting while the cost of scarce engineering talent has been escalating. These factors have made design graphics exceedingly attractive from an economic viewpoint.

DESIGN GRAPHICS HARDWARE SYSTEMS

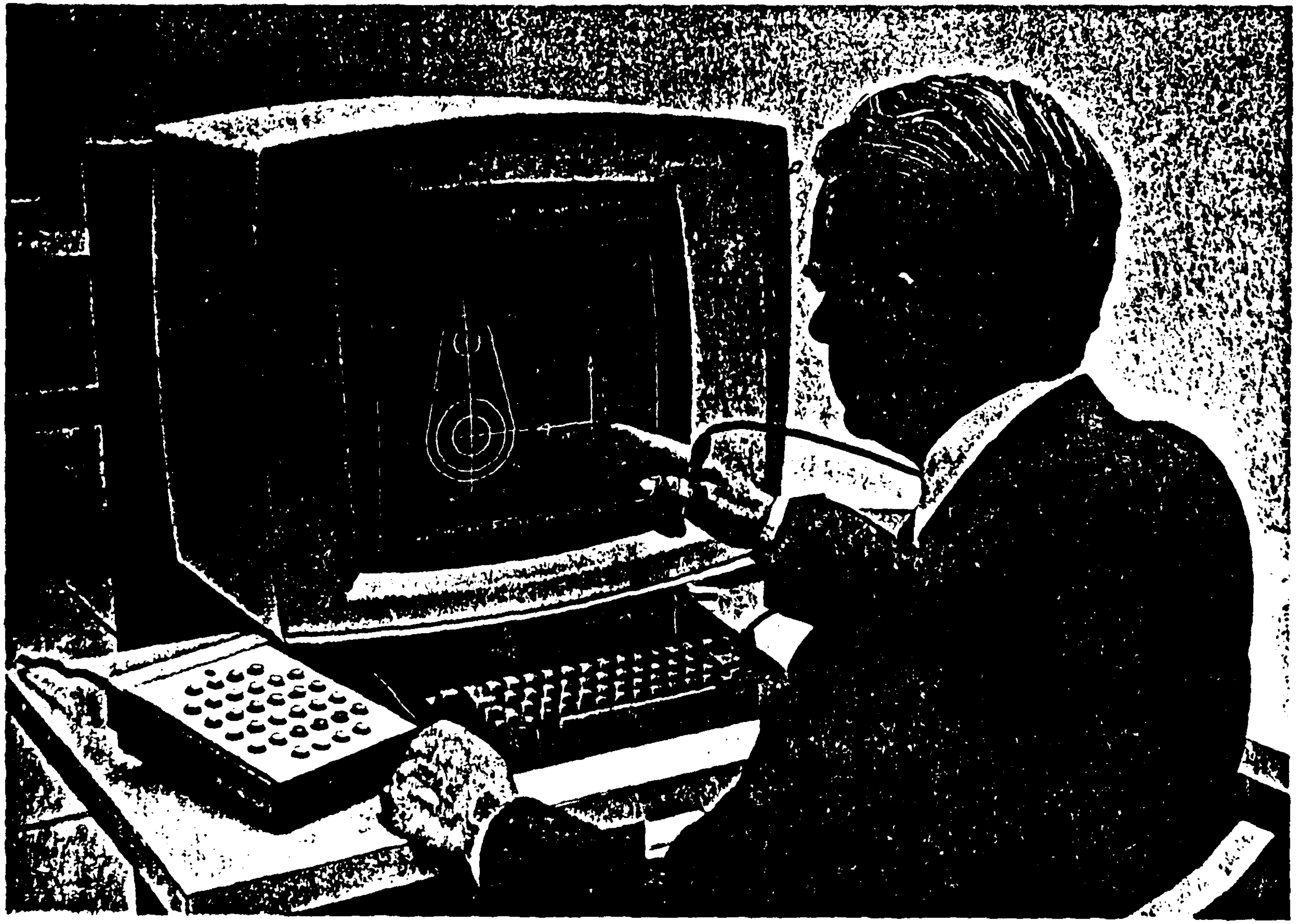
There are a substantial number of offerings by hardware manufacturers which will satisfy design graphics users. Each of these firms have different options, software packages, etc. available for general design/drafting/manufacturing needs. Also some of the units fulfill very specific design requirements. This especially is true when systems with complex analysis abilities are considered. In addition to the large number of available systems,

many companies, and in particular aerospace companies, have developed their own brand of computer graphics.

Lockheed Corporation is one of those aerospace companies which have developed their own system. It is marketed by IBM and is called CADAM (Computer Augmented Design and Manufacturing). CADAM has been in existence for about 10 years. Naturally, as with all technology, CADAM has proceeded through successive stages of greater technical sophistication and versatility. As an employee of Lockheed Missiles and Space Company, I have been involved with CADAM for a number of years and really have a somewhat limited expertise with other products. It is not necessary to this presentation for a hardware discussion of all the potential graphic systems, since we are going to concentrate on the documentation aspects of the peripherals. These documentation units tend to have very similar characteristics in all systems and the following discussions will not be greatly influenced by the hardware.

CADAM SYSTEM HARDWARE

It is necessary to briefly describe the system which is best known to me to understand the subsequent documentation process. Figure 1 shows a typical CADAM work station. The system is highly User oriented and extremely responsive. A designer uses three basic devices to create a drawing. The first is a Function Key Board which is used to select points, lines, splines, certain analyses, etc. The Light Pen is an actuator and locator for those functions. The Typewriter Keyboard is an input device for alphameric characters. Bills of material and notes are examples where this capability is used.



Graphic Display Terminal

Figure 1

Figure 2 is a pictorial description of the hardware that makes up a typical installation. The central computer is an IBM 370/365 which in turn has coaxial lines running to controllers. Long distance cable runs require long line adapters. Each controller will handle 2 work stations and normally 4 work stations are placed together as a module. A high speed printer, card reader, magnetic tape unit and disk storage units are also part of the main CADAM data processing system. The peripheral documentation generation devices produce numerical control punched tapes, microfilm, x-y plotter drawings and hard copy.

Figure 3 highlights a particular microfilm output device. In this case, the unit is a COMP 80 film plotter. A CADAM magnetic tape is loaded on the film plotter each night and ultimately 35mm aperture cards are produced for distribution. This is by far the most economic method of generating viable documentation output. If hard copy is required in areas such as manufacturing, microfilm printer-readers are readily available.

Figure 4 describes the Cal Comp 7000 x-y plotter. This device is an ink on paper/mylar unit.

The plotter is in reality a precision drawing system capable of great accuracy and repeatability. Line widths and colors can be varied depending upon the output requirements and use. Loft drawings drawn on mylar are a perfect example of a quality drawing product using this system. The plotters are expensive and slow compared to other hard copy methods.

CADAM

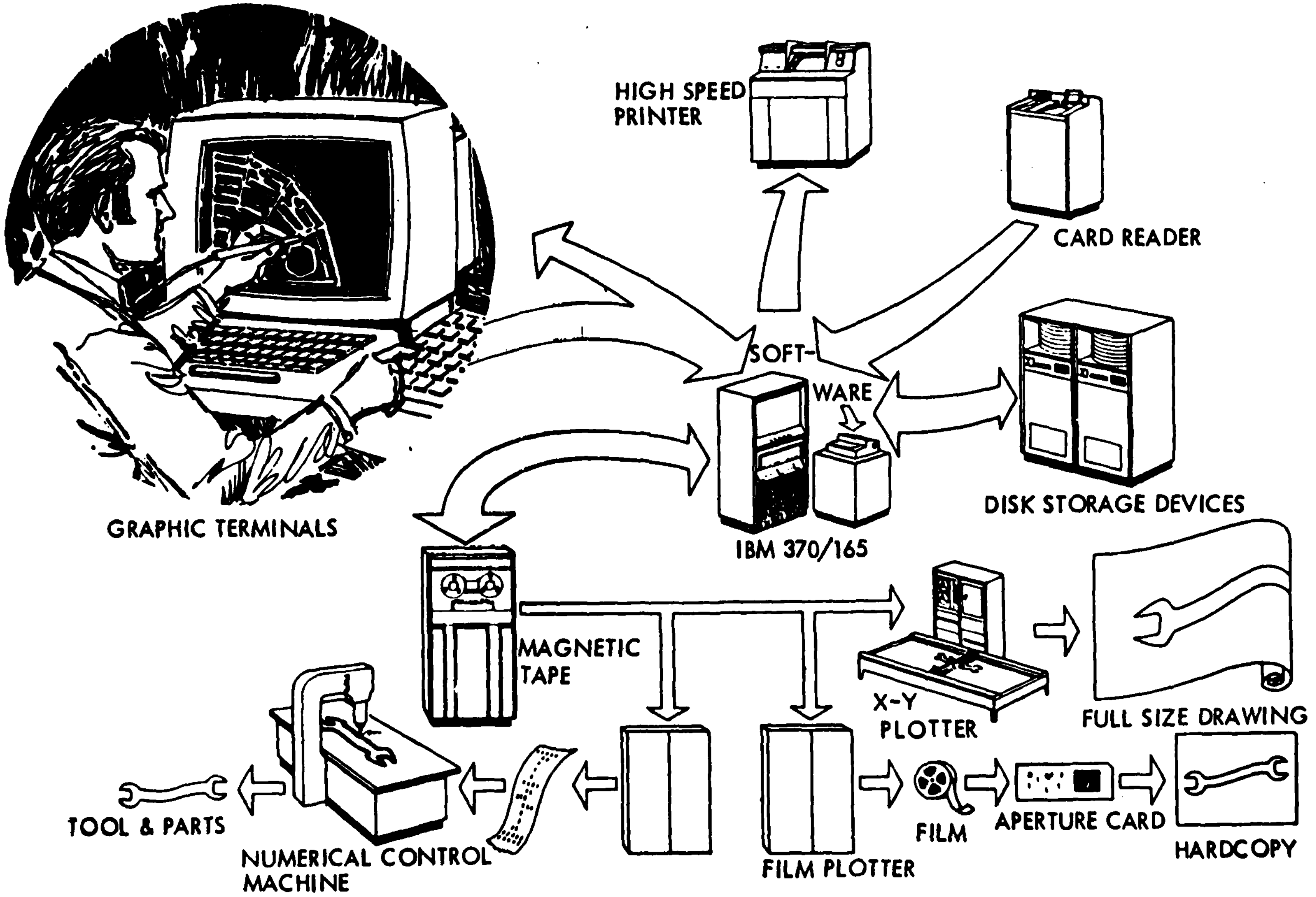


Figure 2

FILM PLOTTER (COMP 80)

- PRODUCES HIGH QUALITY, HIGH RESOLUTION 16 & 35 MM FILM
- CAN DO:

  CONTINUOUS STRIP PLOTS – 300 FRAMES/HR

  FORMS GENERATION

  FRAME ROTATION
- STRUCTURED FOR ADDITION OF MICROFICHE CAMERA

Figure 3

X-Y PLOTTER (CAL COMP 7000)

- PRECISION DRAWING SYSTEM
- LARGE SIZE HIGH QUALITY DRAWINGS
- RECOMMENDED WHEN HIGH QUALITY AND ACCURACY OR LARGE SIZE DRAWINGS ARE NEEDED
- MAX DRAWING SIZE – 48 IN. x 820 IN.

  ACCURACY – ±0.005

  REPEATABILITY – ±0.002

  3 LINE SIZES – LIGHT, MEDIUM, HEAVY

  4 COLORS – BLACK, BLUE, RED, GREEN

Figure 4

A device such as an x-y plotter is almost certainly required if Class I, Type I microfilm is required. Ideally, output from the plotter should be generated only once and that should be at the end of the contract or at the time of documentation delivery.

Figure 5 describes a hard copy output device which is primarily used for an engineering or checking output. The engineers have one of these units very close to the design station and can periodically pull a copy to determine and analyze his progress. Once he feels his design is completed, copies are produced and distributed to check other organizations for approval authority. In Lockheed, we are presently using Versatec units which generate prints in about 30 seconds. Figure 6 shows a typical unit with a plot which uses 100 points to the inch. Figure 7 shows a 200 point per inch plotter output.

Figure 8 highlights the functions associated with the numerical control aspects of a design graphics system.

A numeric control (NC) programmer develops an operational sequence which directs a machine tool (eg. mill cutter) to produce a part. Since the NC programmer and the designer are using common geometry sub-processes, the number of cut-and-try patterns are greatly reduced and sometimes eliminated all together. NC programs within most systems actually show the cutter path on the display after the process has been finished. Editing of the cutter path instructions are easy. These editing and verification functions reduce time-spans and labor costs. Importantly, first-time parts have lower scrap rates and tool set-up times improve.

HIGH SPEED PLOTTER (VERSATEC)

- ELECTROSTATIC, DOT MATRIX DEVICE
- APPEARANCE
- PRIMARY PURPOSE:
  - PRELIMINARY REVIEW PRINTS
  - CHECKPRINTS
  - COORDINATION COPIES
- TWO SIZES
  - 11 INCH BY __________
    - 200 DOT/INCH
  - 36 INCH BY __________
    - 100 DOT/INCH
  - 36 INCH 200 DOT/INCH AVAILABLE

Figure 5

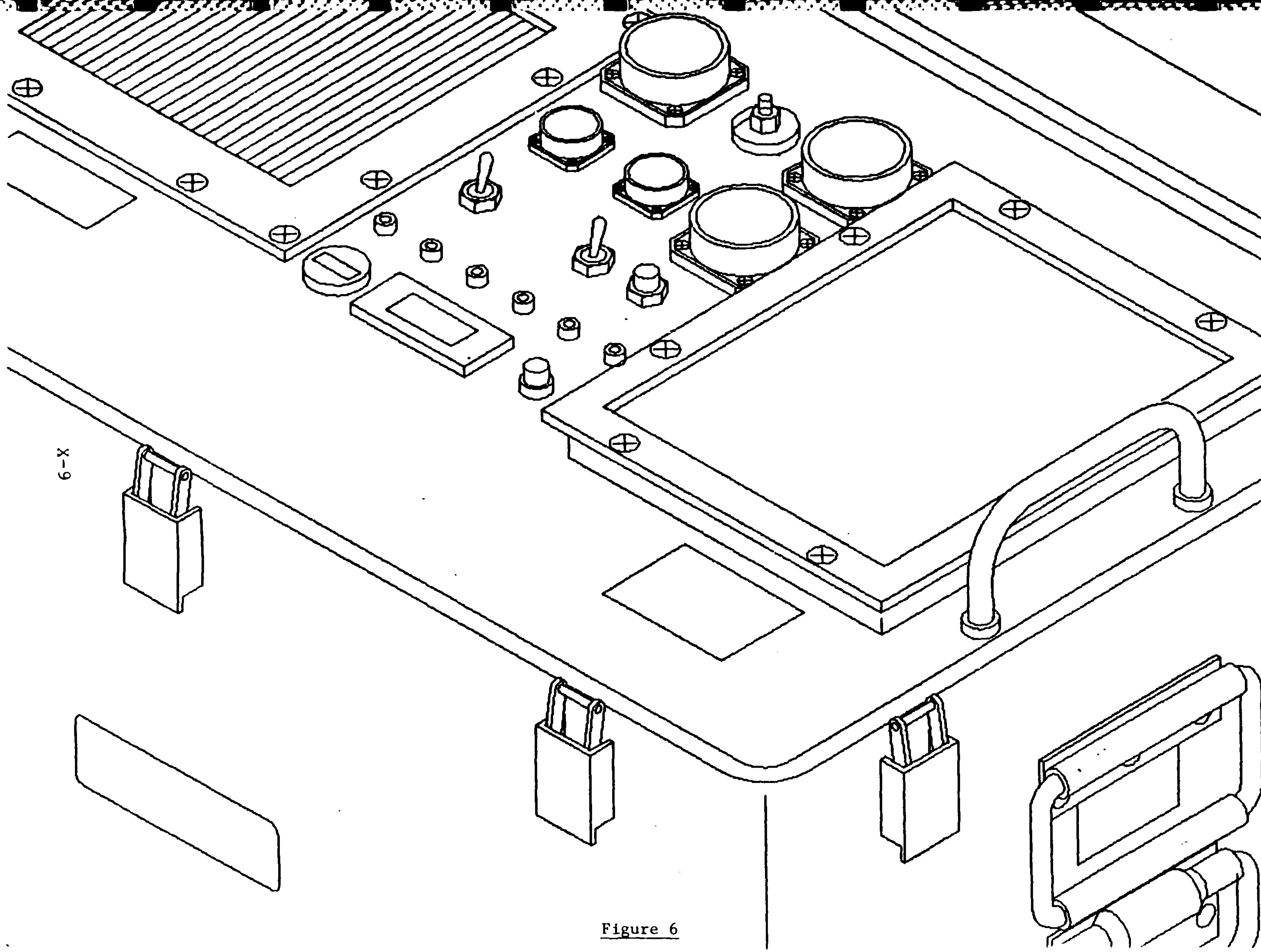
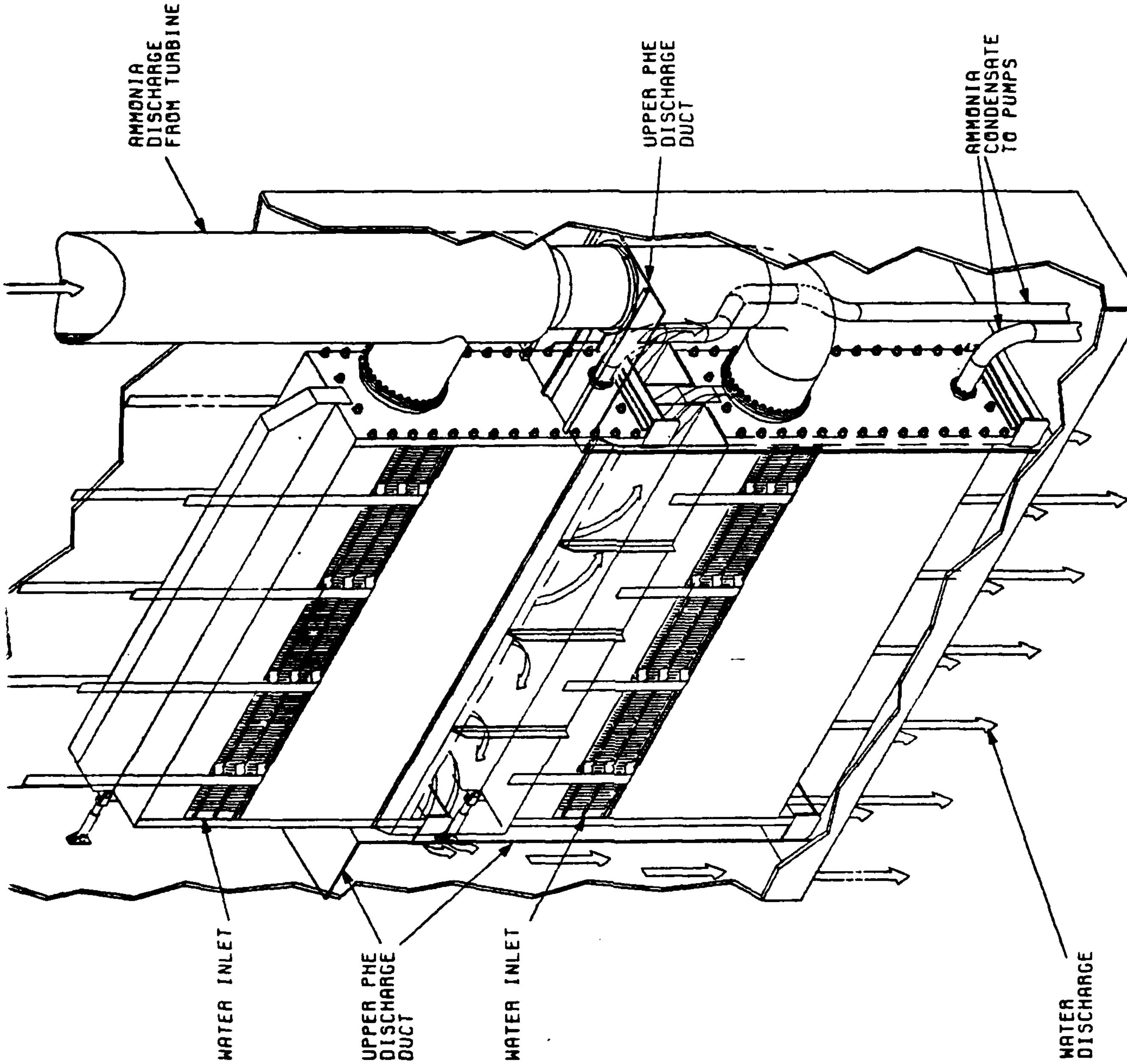


Figure 6



CONDENSERS SHOWN-EVAPORATORS SIMILAR

Figure 7

N/C TAPES

N/C FUNCTION PROVIDES PROGRAMMER WITH FACILITY TO:

GENERATE CUTTER PATH INFORMATION

VERIFY AND EDIT CUTTER PATH INFORMATION

MAGNETIC TAPES GENERATED BY CADAM MUST BE PROCESSED TO PRODUCE PUNCHED TAPES FOR NC MACHINES

Figure 8

PARTS LISTING

Parts listing is also a very important facet of the entire drawing process. The question is whether it should be done manually on a design graphics system or generated separate parts list on a different comper system. The proper way to analyze the method for generation of parts data is to determine the economic trade-offs available. I have come to the conclusion that separate parts lists should be used wherever possible. This is especially true if the separate parts list is computer generated.

The reasoning behind this decision is as follows:

- o Engineers and scientists are not known for their talents as a typist. From an economic point of view, they are slower (less productive), and more expensive than a skilled parts lister working from some sort of input transmittal.
- o Any computer design graphics system is inherently expensive. Typing out a parts list can be very costly and temporarily removes the machine out of the design stream. In other words, don't use a computer graphics system as a typewriter for integrated bills of material unless your Customer insists.
- o Finally, no design graphics system that I am aware of has the sophistication to interface with inventory, material processing, manufacturing or engineering files. This is the area where automated parts listing pays off. Creation of purchase orders, inventory data, etc. would be non-existent in the present day operational methods of such systems.

DOCUMENTATION FLOW

The documentation flow process is quite different for each company. It can be even different for Divisions within a company. For purposes of this discussion, Figure 9 represents a very simplistic model of a typical path for an engineering drawing.

At the beginning of the design task, an engineer requests a drawing number from Data Control. In turn, Data Control gives the engineer a drawing number, captures pertinent information concerning that drawing and records that informatinn into a computerized drawing tracking system. Next, the engineer creates a design on the computer graphics system and prepares a bill of material transmittal which is input into the computer system by Data Control personnel. Once the design and parts list has been completed, the engineer obtains the desired quantity of hard copy prints. These are distributed to the checker and other interested individuals who are in the drawing approval loop. When the drawings are determined to be correct and adequate, the drawing is "signed". This is where the control becomes difficult since signatures are not well suited for design graphics input and ultimate drawing control. Ideally, the checker space on the title block is reserved and can only be accessed by the checker using a password. The password described on Page 8, opens this signature block to alphameric entries. The identical process can also be accomplished for safety, product assurance, Customer, etc. Once assigned in the computer system, the drawing technically released is available for use.

Overnight released microfilm is created and distributed to all interested agencies. Data Control records its required information on the computer system

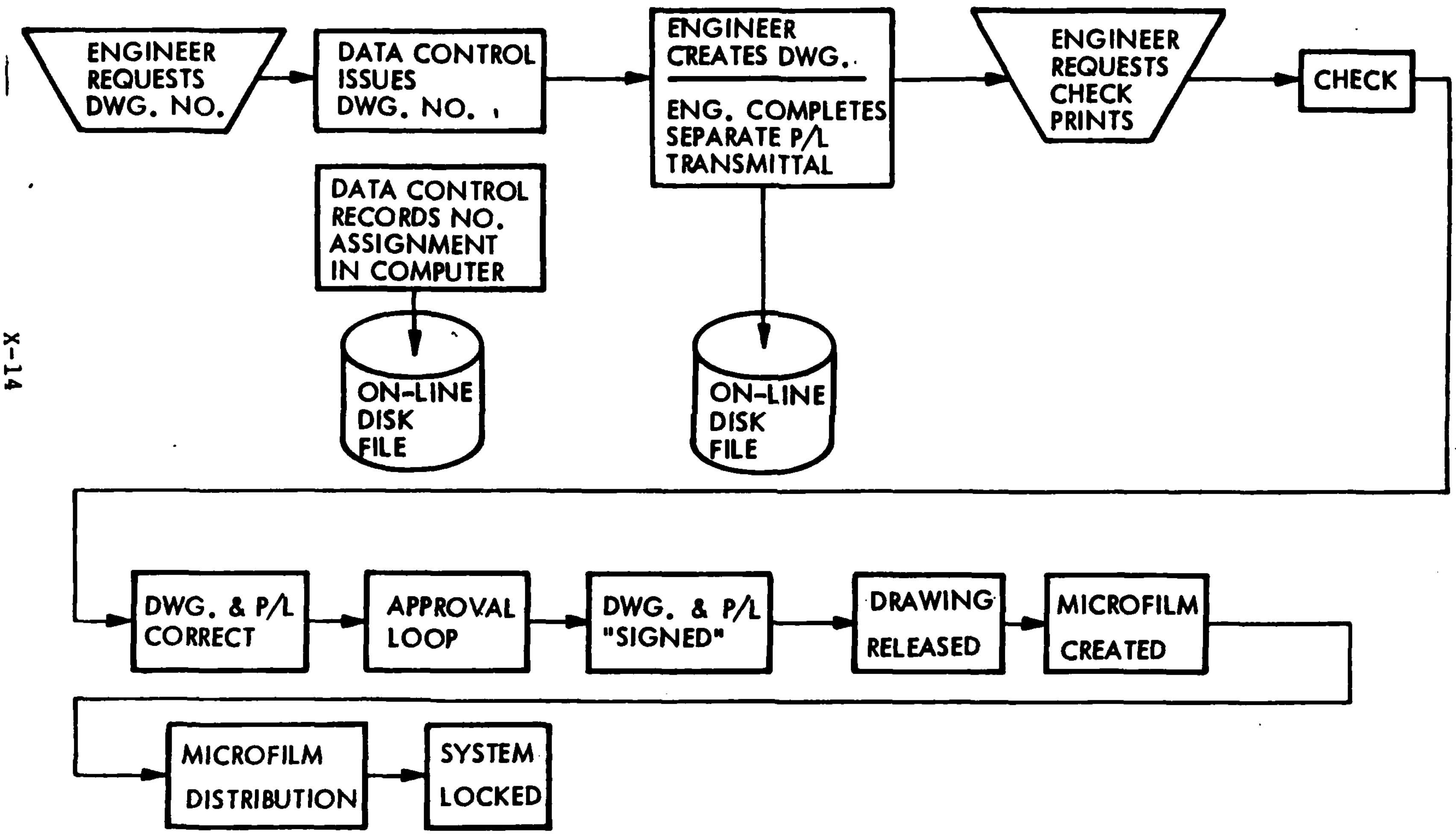

ENGINEER REQUESTS DWG. NO.
DATA CONTROL ISSUES DWG. NO.
DATA CONTROL RECORDS NO. ASSIGNMENT IN COMPUTER
ON-LINE DISK FILE
ENGINEER CREATES DWG.
ENG. COMPLETES SEPARATE P/L TRANSMITTAL
ON-LINE DISK FILE
ENGINEER REQUESTS CHECK PRINTS
CHECK
DWG. & P/L CORRECT
APPROVAL LOOP
DWG. & P/L "SIGNED"
DRAWING RELEASED
MICROFILM CREATED
MICROFILM DISTRIBUTION
SYSTEM LOCKED

Figure 9

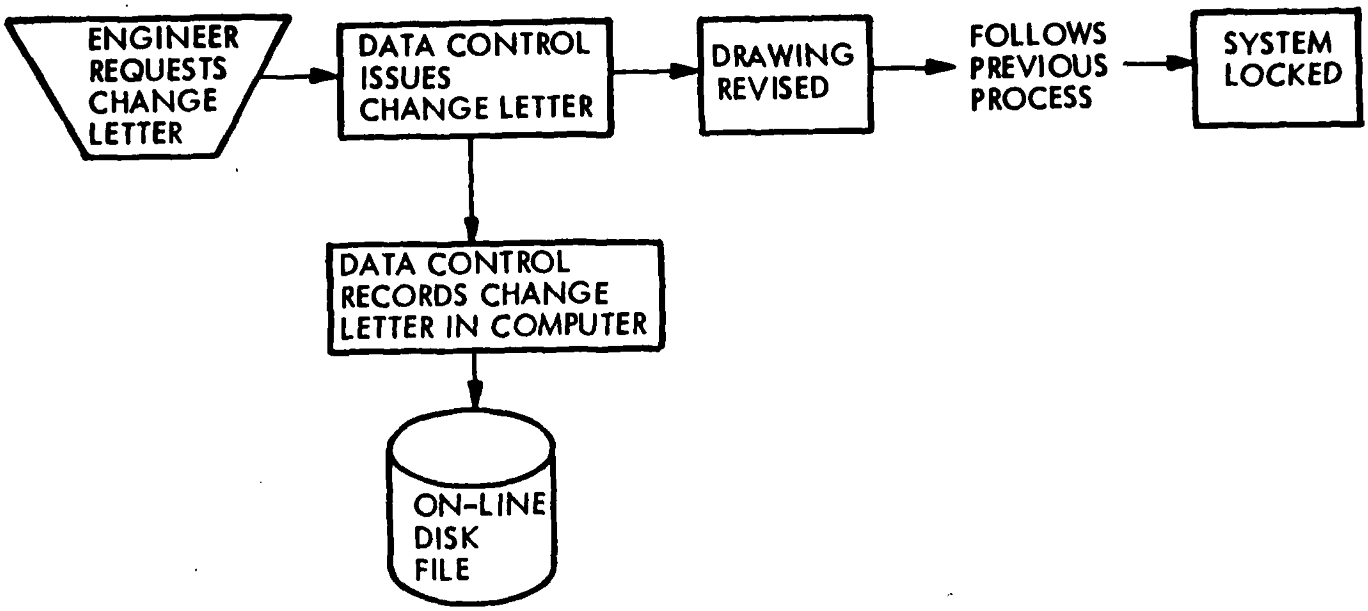


Figure 10

DOCUMENTATION PROTECTION

- SECURITY
  - FILE PROTECTION
  - CLASSIFIED
- DATA STORAGE
- DISASTER FILES

Figure 11

easiest and most economical method. Hard copy can be produced from magnetic tape on printers, x-y plotters and video presentations with microfilm aperture cards generating hard copy. Both medias are excellent to maintain drawing history.

DISASTER FILES

Figure 10 shows a simple flow diagram of the disaster file method used by my firm and I believe it is somewhat typical throughout the industry. The figure is quite self-explanatory, but the timing is important and deserves some explanation.

During a design session, the engineer "files" his drawing about every 10 or 15 minutes. This action protects his data in the event of a computer failure which could wipe out his information. The log tape captures the design data for processing overnight. This is also the magnetic tape which is placed in the library. At the same time, active drawings or work in process resides on the disk files. At the end of the month, the library tapes are sent to an off-site location. These are known as the "father" tapes. They represent a data processing compilation of the previous month's work. These data replace that design information generated during the previous month which are now referred to as "grandfather" tapes. These tapes reside in a vault area. As data and designs become inactive, the tapes are scratched and recycled for further use.

The above file protection methods are basically oriented toward proprietary data control, although the third method does permit close monitoring of classified data. For proprietary data, the "read only" mode is readily available to all concerned program personnel. This is not necessarily true for classified information.

Speaking of classified information on computer files, we must examine file protection with a different set of parameters. Generally speaking, a drawing or a small number of drawings, is not classified. The problem of security occurs when all of the drawings are available in one package. This is precisely the situation when a complete set of project drawings reside on a magnetic tape file or in on-line working storage. Communications from work stations to a host computer also pose additional security problems.

After due consideration, it appears that stand-alone computer design graphics systems have the greatest inherent classified protection. Being self contained, with its own documentation output devices, and in special constructed areas automatically prohibit a number of problems from occurring with communications and document handling. This combined with a double password system lock and auditable security procedures should eliminate the usual classification difficulties.

DATA STORAGE

Economic factors and the operational methods of a Company dictate how, when and where documentation is handled and stored. From a strictly design graphics point of view, microfilm and magnetic tape files appear to be the

and locks down the system to prevent further change.

DOCUMENTATION PROTECTION

SECURITY

The security, both proprietary and classified, aspect of a design graphics system is a serious concern. Everyone has heard the horror stories of unauthorized individuals violating computer files. The situation with design graphics is no different. In a typical design graphics computer system, there are or can be three methods of file protection. First is the conventional password technique where each engineer, checker, etc. has his own unique code to allow file access. It is important that treatment of the password carries the same importance and disciplinary action as those associated with security-type (3 tumbler) combination locks. Otherwise design personnel will be "trading" passwords thereby destroying the file protection.

A second method which inhibits unauthorized file access is a log tape. Effectively this tape records all activity during a given day which allows a reasonably good audit trail.

A third, and usually most positive method, requires both an operator's password and a control password input by an individual who oversees the given area of design or a supervisor. This action can be documented by requiring a sign-in/sign-out procedure for control and audit.

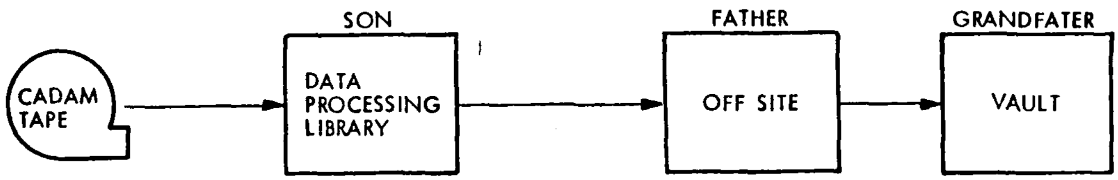

SON
FATHER
GRANDFATER
CADAM
TAPE
DATA
PROCESSING
LIBRARY
OFF SITE
VAULT

Figure 12

SUMMARY OF CHANGES INCORPORATED IN DOD-STD-100C

(SUPERSEDES MIL-STD-100B)

Prepared by: LORNA BURNS

12 April 1979

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Fullerton, California 92634
(714) 732-2013

SUMMARY OF CHANGES INCORPORATED IN DOD-STD-100C
(supersedes MIL-STD-100B)

	DESCRIPTION	DOD-STD-100C PARAGRAPH
1.	The following IEEE callouts replaced ANSI designations with no technical differences.	General

IEEE STD 91-1973	Graphic Symbols for Logistic Diagrams (Two-state Devices). (Same as ANSI Y32.14-1973)
IEEE STD 200-1975	Reference Designations for Electrical and Electronics Parts and Equipment. (Same as ANSI Y32.16-1975)
IEEE STD 280-1967	Letter Symbols for Quantities used in Electrical Science and Electrical Engineering. (Same as ANSI Y10.5-1968)
IEEE STD 315-1975	Graphic Symbols for Electrical and Electronics Diagrams (including Reference Designation Class Designation Letters). (Same as ANSI Y32.2-1975)

2.	Scale requirements have been added. They are essentially the same as those previously contained in MIL-STD-100A except a straight line is used to underline not-to-scale dimensions.	101.1 & 106
3.	Continuation sheets of multisheet drawings prepared using automated preparation techniques need not be the same size as the first sheet - added.	101.1.1
4.	Line conventions and lettering per ANSI Y14.2-1979; was ANSI Y14.2-1973. ANSI Y14.2M-1979 adds standard metric line widths and lettering heights; allows the use of open arrowheads and a single line width for all lines on computered prepared drawings; adopts the symmetry and chain lines from ISO/DIS 128. (The M in the document number indicates the standard is compatible with metrication.)	101.2*
5.	Provisions for using isometric, pictorial, etc, views - added.	101.3.1

* Issue dates per Applicable Documents listing.

DESCRIPTION	DOD-STD-100C PARAGRAPH
6. Application of the metrics system in new designs per DOD-STD-1476 - added. DOD-STD-1476 provides guidance for metrication, including use of existing inch items in new metric designs; defines such terms as "metric design", "soft-", "hard-conversion"; requires reidentification of hard converted items (considered new metric items); references ASTM E-380 for metric units, practices, and usage (basically SI units).	101.4.1
7. Surface texture, waviness, etc, per ANSI B46.1-1978; was ANSI B46.1-1962. ANSI B46.1-1978 covers definitions, method of measurement, etc, for both customary and metric units.	101.6*
8. Surface texture symbols per ANSI Y14.36-1978 - added. ANSI Y14.36-1978 establishes surface texture drafting practices (generally compatible with ISO 1302) using either customary or metric units; adds symbols for indicating "material removal by machining required/prohibited." (Error in Figure 2.)	101.6.1*
9. Screw thread representation per ANSI 14.6-1978; was ANSI Y14.6-1957. ANSI Y14.6-1978 provides improved definition for representing screw threads on drawings; recommends simplified representation and associated designations; includes only a minimum of related design information.	101.7*
10. Bevel and hypoid gear delineation per Y14.7.2-1978 - added. Y14.7-1958 has been deleted. The second part of the proposed four part standard is now available. (The third part is currently being coordinated.)	101.8*
11. Symbols for plumbing fixtures in architecture and building construction per Y32.4-1977 - added.	102.1.6.1*
12. Symbols for aircraft hydraulic and pneumatic systems per ANSI/SAE AS1290 (July 1975) - added.	102.1.7.1*
13. Structual symbols per MIL-STD-18 deleted. (Document cancelled.)	102.1.8
14. Welding symbols per ANSI/AWS A2.4-1976 and terms and definitions per AWS A3.0-1976; was ANSI Y32.3-1969 and AWS A3.0-1969.	102.1.11*

* Issue dates per Applicable Documents listing.

	DESCRIPTION	DOD-STD-100C PARAGRAPH
15.	Nondestructive testing symbols per ANSI/AWS A2.4-1976; was ANSI Y32.17-1972.	102.1.12*
16.	Letter symbols for units per ANSI/IEEE Std 260-1978; was ANSI Y10.19-1969.	102.3.1*

ANSI/IEEE Std 260-1978 provides symbols for used when only limited character sets are available (e.g., all upper or lower case letters, no Greek characters, etc). (Conflicts with Method 2 contained in Table 8-1 of ANSI Y14.15-1966, reaffirmed 1973, which covers electronic diagrams.)

17.	ANSI Y14.15b-1973 - added.	103.1*
18.	Printed wiring board description in digital form per ANSI/IPC-D-350B (August 1977) - added.	103.3.1, 201.9.8.1.1, & 201.9.9.1*
19.	Shopping list of materials for drawing originals, duplicate originals, and reproductions - added as follows:	104

SPECIFICATIONS

Federal

L-F-340	Film, Diazotype, Sensitized, Moist and Dry Process, Roll and Sheet
L-P-519	Plastic Sheet, Tracing, Glazed Matte

SPECIFICATION

Federal

UU-P-221	Paper, Direct-positive Sensitized, (Diazotype-Moist and Dry Process)
UU-P-561	Paper, Tracing
CCC-C-531	Cloth, Tracing

Military

MIL-D-5480	Data, Engineering and Technical Reproduction Requirements For
MIL-D-8510	Drawing, Undimensioned, Reproducibles, Photographic and Contact Preparation Of (ASG)
MIL-M-38761	Microfilm and Microfilm Frame Deck Used for Recording Engineering Drawings and Associated Data
MIL-P-55010	Plastic Sheet, Polyethylene Terephthalate

These document are applicable only to the extent specified by each individual contract.

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* Issue dates per Applicable Documents listing.

	DESCRIPTION	DOD-STD-100C PARAGRAPH
20.	Restrictions on use of duplicate drawing originals - added.	104.1
21.	Requirement that all drawings pertaining to items using radioactive materials be marked with a caution note - added.	107
22.	Provisions for continuing columns of integral parts lists - added. Parts list format requirements clarified.	201.1.2
23.	New note required on printed wiring master pattern drawings which must be on stable base material - added.	201.9.8.1
24.	Layout drawing criteria - added.	201.10
25.	Numbering of associated lists clarified.	402.8
26.	Reidentification of non-interchangeable parts is required up to <u>and including</u> the assembly where interchangeability is re-established - revision.	402.14, Cond 5
27.	Identification requirements for bulk materials are clarified.	402.16.4
28.	Reference to DOD-D-1000 paragraph 3.8 on contractor reference documents and requirements for data submittal - added.	402.18
29.	Guidelines for use of latest symbols, abbreviations, drafting practices, etc - added.	502.3
30.	The restriction that the revision block be blank on the initial document release has been deleted.	503.2
31.	Location of revision identification on multisheet drawings clarified.	505
32.	The requirement for new approval/authentication signatures on redrawn drawings has been deleted.	506
33.	"Items listed on a subordinate parts list or reference document are not repeated in using assembly parts list unless ..." - added.	601.1
34.	Design activity identification is now a mandatory block on all associated lists (PL, DL, IL); <u>was</u> optional. Requirement for address in this block has been deleted.	603.2.1 604.3.1 605.3.1
35.	The requirement that the contract number be entered on all sheets of associated lists has been deleted.	603.2.2 604.3.2 605.3.2
36.	"FSCM" has completely replaced "code ident".	General
37.	The term "non-government standards" has replaced "industry standards".	General

DESCRIPTION	DOD-STD-100C PARAGRAPH
38. The following definition changes have been incorporated:	
Assembly - note revised	704
Duplicate original - added	717A
Company Standard - revised (references DOD-D-1000 only)	746
Non-government Standard was Industry Standard; also excludes Company Standard - added.	748

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